Document ID:EDF-3943
Revision ID:0
Effective Date:12/18/03

Engineering Design File

PROJECT NO. 23502

INTEC Injection Well: Summary of Historical Information and Groundwater Quality Trends

Idaho National Engineering and Environmental Laboratory

EDF No.: 3943 EDF Rev. No.: 0 Project File No.: 23502

1. Title: INTEC Injection Well: Summary of Historical Information and Groundwater Quality Trends

2. Index Codes:
Building/Type CPP-23 SSC ID ______ Site Area INTEC

3. NPH Performance Category: ______ or ☒ N/A

4. EDF Safety Category: ______ or ☒ N/A SCC Safety Category: ______ or ☒ N/A

5. Summary: This Engineering Design File summarizes existing information regarding the history of the former CPP-23 injection well at the Idaho Nuclear Technology and Engineering Center. The injection well received service waste from 1952 through 1986 and was plugged in 1989. This document also includes historical information regarding composition of service waste stream and groundwater quality trends in the Snake River Plain Aquifer downgradient of the injection well.

6. Review (R) and Approval (A) and Acceptance (Ac) Signatures:
(See instructions for definitions of terms and significance of signatures.)

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Doc. Control	AC	Annie Buttars/3G14	Annie Buttars	12/17/03

7. Distribution:
(Name and Mail Stop)

8. Does document contain sensitive unclassified information? ☐ Yes ☒ No
If Yes, what category:

9. Can document be externally distributed? ☒ Yes ☐ No

10. Uniform File Code: UFC-6102 Disposition Authority: ENV1-h-1
Record Retention Period: Cutoff at submission of final financial status report for the site, or after resolution of all issues rising from litigation, claim, negotiation, audit, cost recovery, or other action, whichever is later. Destroy 10 years after cutoff with written approval from EPA award official.

11. For QA Records Classification Only: ☐ Lifetime ☒ Nonpermanent ☐ Permanent
Item and activity to which the QA Record apply: N/A

12. NRC related? ☐ Yes ☒ No

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13. Registered Professional Engineer's Stamp (if required) N/A

EXECUTIVE SUMMARY

The former Idaho Nuclear Technology and Engineering Center (INTEC) injection well was routinely used to discharge INTEC service wastewater to the Snake River Plain Aquifer (SRPA) from 1952 to February 1984. During its operation, the injection well constituted a source of low-level radioactivity to the aquifer. The principal radionuclides of environmental significance discharged to the injection well were tritium (H-3), strontium-90 (Sr-90), iodine-129 (I-129), and cesium-137 (Cs-137), with tritium accounting for the vast majority of the total curies.

This Engineering Design File (EDF) document summarizes known historical information regarding the installation, construction, reconstruction, and decommissioning of the former INTEC injection well. Available information regarding the composition of the service wastewater discharged to the injection well was summarized and used to calculate a revised estimate of the total amount of 1-129 discharged to the injection well. Groundwater quality impacts and trends in the SRPA downgradient of the former injection well are also summarized.

The results of these studies indicate that

- The service waste stream contained very little suspended solids, and “sludge” did not accumulate in the injection well.

- Solid material that remained at the bottom of the injection well in 1989 at the time the well was plugged consisted of sloughed well filter pack material and interbed sediments (not “sludge” derived from the service waste).

- The amount of 1-129 previously assumed to have been discharged to the injection well during its operation was approximately 40% too high. A revised estimate of the total amount of 1-129 discharged to the injection well indicates a total of approximately 0.86 Ci (as opposed to the previous estimate of 1.39 Ci).

- Tritium activities have declined below the drinking water maximum contaminant level (MCL) in all downgradient aquifer monitor wells and in nearly all perched water monitor wells at INTEC.

- Sr-90 levels in perched water monitor wells closest to the former injection well are at or below the MCL. However, Sr-90 activities in several aquifer monitor wells downgradient of the former injection well remain up to five times higher than the drinking water MCL, and two perched water monitor wells close to the tank farm contain very high Sr-90 activities. The distribution of Sr-90 strongly suggests that the primary source of Sr-90 in the perched water is contaminated soils in the vicinity of the tank farm, not the former injection well.

- Iodine-129 activities in the aquifer have declined below the MCL in all SRPA monitor wells and in all the perched water monitor wells. Given the low I-129 activities that currently exist in the aquifer, there is no evidence

that there is a significant 1-129 source near the INTEC injection well. If a residual 1-129 source still exists, the data indicate that it is releasing 1-129 at a very slow rate, and significant hture increases in 1-129 activity in the groundwater are not likely.

- Volatile organic compound (VOC) concentrations in the aquifer at and downgradient of the former injection well are far below MCLs for all compounds. Based on process knowledge and groundwater monitoring results, there is no evidence that the injection well was ever used for routine disposal of organic compounds, and there is no indication of any significant historical or existing source of VOCs in the vadose zone or groundwater near the former injection well.

In summary, tritium and 1-129 activities are already below their respective MCLs in the aquifer downgradient of INTEC, and no significant residual sources of these two radionuclides appear to exist at or near the former injection well. Sr-90 activities in the aquifer currently exceed the MCL downgradient of INTEC, and vadose zone and aquifer matrix materials near the tank farm appear to constitute a residual secondary source of Sr-90 to groundwater. However, Sr-90 concentrations are slowly declining in wells near and downgradient of INTEC, and groundwater quality trends indicate that Sr-90 activities in groundwater outside the INTEC security fence will decline below the MCL by 2095. The remedial investigation of the tank farm being performed under Operable Unit 3-14 will address hture impacts of contaminated tank farm soils on the aquifer, including residual Sr-90 in the shallow perched water.

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FIGURES

TABLES

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ACRONYMS

bls	below land surface
COC	contaminant of concern
CPP	Chemical Processing Plant (designation for buildings and areas at INTEC)
EDF	Engineering Design File
FFA/CO	Federal Facility Agreement and Consent Order
HLLW	high-level liquid waste
ICPP	Idaho Chemical Processing Plant (now INTEC)
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
MCL	maximum contaminant level
OU	operable unit
PEW	process equipment waste
RAO	remedial action objective
RI/BRA	remedial investigation/baseline risk assessment
SRPA	Snake River Plain Aquifer
TCA	trichloroethane
USGS	United States Geological Survey
VOC	volatile organic compound
WCF	Waste Calcining Facility (CPP-633)

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INTEC Injection Well: Summary of Historical Information and Groundwater Quality Trends

1. INTRODUCTION

The former Idaho Nuclear Technology and Engineering Center (INTEC) injection well, located at the north edge of Building CPP-666 (Figure 1), was routinely used to discharge INTEC service wastewater to the Snake River Plain Aquifer (SRPA) from 1952 to February 1984. When it was in operation, the injection well constituted a source of low-level radioactivity to the aquifer. The principal radionuclides of environmental significance discharged to the injection well were tritium (H-3), strontium-90 (Sr-90), iodine-129 (I-129), and cesium-137 (Cs-137), with tritium accounting for the vast majority of the total curies.

Because the injection well discharged radionuclides directly to the aquifer, it has long been the focus of environmental scrutiny. As a result of lingering questions and concerns regarding the possibility that the former injection well might constitute a significant residual source of contaminants to the aquifer, a review of historical information and files was conducted. This Engineering Design File (EDF) summarizes known historical information regarding the installation, construction, reconstruction, and decommissioning of the former INTEC injection well. Available information regarding the composition of the service wastewater discharged to the injection well is summarized and used to calculate a revised estimate of the 1-129 discharged to the injection well. Groundwater quality impacts and trends in the SRPA downgradient of the former injection well are also summarized.

2. HISTORICAL SUMMARY OF INTEC INJECTION WELL

The former injection well was used routinely from 1952 to February 1984 to dispose of service wastewater from INTEC operations to the SRPA. Over the years, the injection well has been variously referred to as Well CPP-03, as Well MEH-FE-PL-304, and by its Federal Facility Agreement and Consent Order (FFA/CO) site designation, CPP-23.

The injection well was drilled during 1950-51 to a total depth of 597 ft below land surface (bls). Beginning in 1952, the injection well received an average of approximately 1 million gallons per day (MGD) of service wastewater. The service waste stream consisted of primarily plant cooling water, demineralizer and boiler blowdown water, and process equipment waste (PEW) evaporator condensates. Figure 2 shows the service waste flow rate into the injection well over its operational lifetime. A total volume of approximately 12 billion gallons of service wastewater was disposed to the injection well during its lifetime.

Two major well failures and reconstruction efforts were conducted during the history of the INTEC injection well. The first reconstruction took place during the fall of 1970 and spring of 1971 upon discovering the injection well was blocked at 226 ft bls. The injection well continued to receive service waste during this reconstruction effort, and emergency discharge lines that had been routed to wells USGS-47 and USGS-48 were never used. The injection well was cleaned to a depth of 596 ft bls and a 9-7/8-in. (inner diameter) polyvinyl chloride (PVC) liner was installed at the conclusion of the 1970-71 reconstruction. Following these repairs, the injection well appears to have operated normally over the next 10 years.

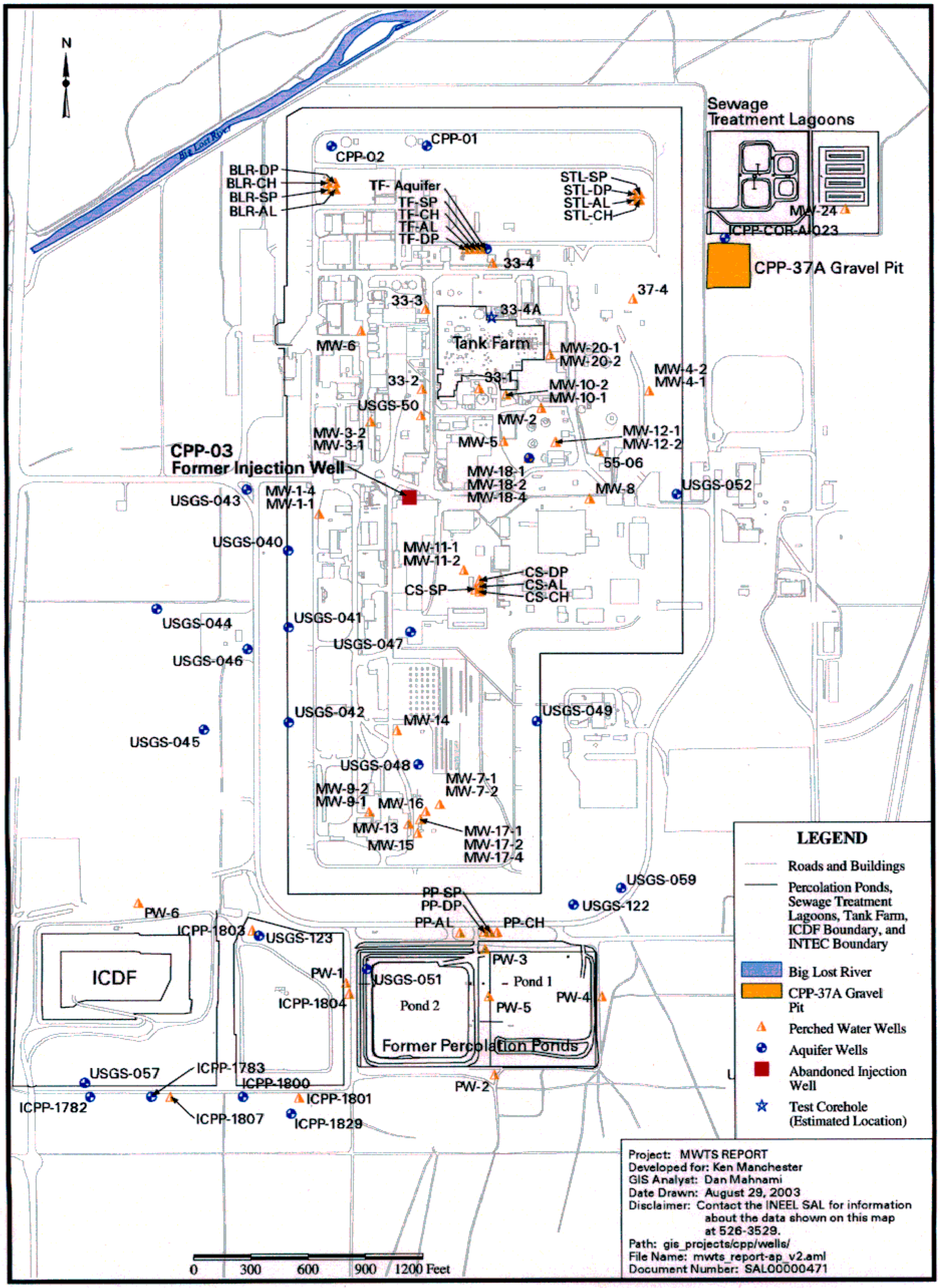

Figure 1. Map of INTEC showing farmer injection well (CPP-03) and nearby groundwater monitor wells.

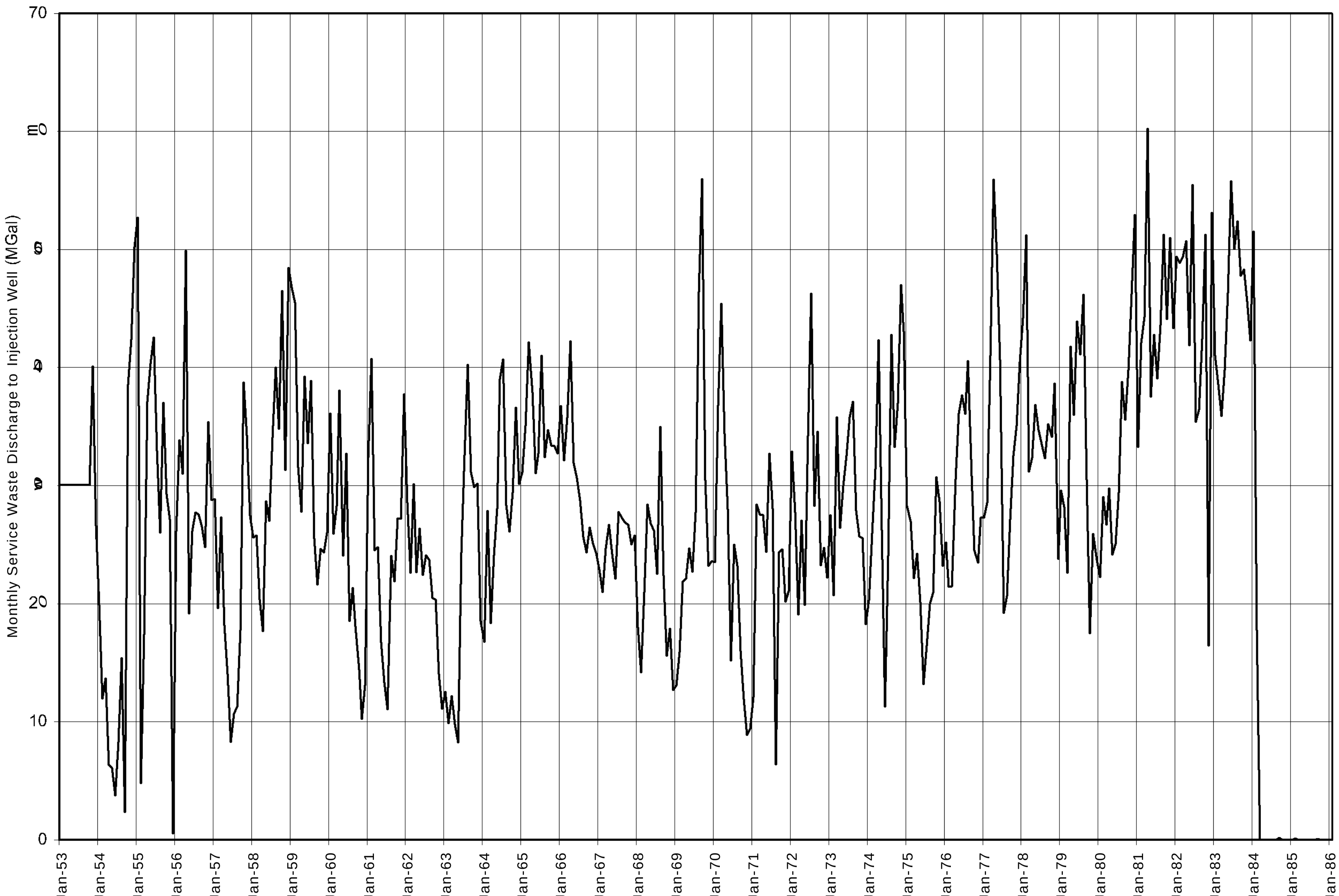

Figure 2. INTEC service waste flow rate to injection well.

In September 1981, the well was again found to be blocked, at a depth of 534 ft bls. In July 1982, the liner was found to be completely collapsed at a depth of 435 ft bls. The service waste stream was diverted to a gravel pit (CPP-37A, Figure 1) located east of INTEC during this reconstruction effort. The well was cleaned to a depth of 585 ft bls during this reconstruction but sand and silt (formation material) continued to flow into the well throughout this effort. Sand was repeatedly bailed from the well, pumped to the gravel pit east of INTEC, and was later boxed and shipped to the Radioactive Waste Management Complex for burial. Efforts to locate information regarding the total volume and any characterization data for the sand have been unsuccesshl. At the conclusion of the 1982 reconstruction effort, a 10-in.-diameter polyethylene liner was placed in the well to a depth of 560 ft.

On February 7, 1984, the injection well was taken out of routine service, and Percolation Ponds 1 and 2 located south of the INTEC facility began receiving the service waste stream. Small amounts of service waste were intermittently disposed of at the injection well during 1984 and 1985, with no use of the well after 1986. The injection well was pressure-grouted with cement and abandoned in October 1989. At that time, the well contained sloughed material below a depth of 475 ft bls. This material consisted of well construction and formation material that entered the well from outside the casing. Appendix A contains additional details regarding the history of the injection well, including the 1971 and 1982 well reconstruction efforts.

3. INTEC SERVICE WASTE COMPOSITION

The service wastewater was composed of a dilute sodium chloride solution that contained lesser amounts of various other inorganic constituents and radionuclides. Radioactive constituents in the service waste were derived primarily from the PEW evaporator condensate waste stream, including tritium (H-3), strontium-90 (Sr-90), iodine-129 (I-129), and cesium-137 (Cs-137). The Remedial Investigation/Baseline Risk Assessment (RI/BRA) (DOE-ID 1997) reported the total activity of each of these radionuclides that was reported to have been discharged to the injection well during the time period for which records are available (Table 1).

Table 1. Reported activity of selected radionuclides discharged to the INTEC injection well during the time neriod when records were kept.[a]

Radionuclide	Half-life (yr)	Total Activity Injected (Ci)	First Monthly Sampling Date
H-3	12.3	21,300	Jan 1962
Sr-90	28.6	16.0	Jan 1962
I-129	15,700,000	0.278	May 1976
Cs-137	30.2	20.5	Jan 1962

a. Source: Radioactive Waste Management Information System database, as shown in Table 4-1 (DOE-ID 1997).

The total tritium activity sent to the injection well during its operation represents approximately 96% of the total curies (DOE-ID 1997). Various other short-lived radionuclides were also present in the waste stream (e.g., cerium-144), but the half-lives of these are so short (<1 year) that they have long since decayed away (DOE-ID 1997). In addition, Cs-137 is not considered to be an injection well contaminant of concern (COC) because of its low solubility and mobility (DOE-ID 1997, Appendix F). Therefore, H-3, Sr-90, and 1-129 are the principal radionuclide COCs associated with service waste disposal in the former injection well.

Appendix B includes graphs of the monthly totals of selected radionuclides discharged to the injection well over the period for which records are available. These data are derived from the Idaho Chemical Processing Plant (ICPP) production monthly reports. Note that data for 1-129 in service waste are only available beginning in 1976, whereas the activities of tritium and Sr-90 in the service waste have been monitored since 1962. The lack of 1-129 data before 1976 is in part because, prior to that time, laboratory analytical techniques were not yet available to detect the low 1-129 activities present in the service waste, as compared to the much higher activities of the other radionuclides.

Examination of the graphs of total monthly discharge to the service waste stream and the injection well show that the rate of discharge of the various radionuclides varied significantly from month to month and year to year (Appendix B). As shown on the graphs, numerous pulses of tritium, Sr-90, and 1-129 occurred over time in the service waste stream. These pulses are believed to represent batches or slugs of PEW evaporator condensate that mixed with a much larger volumetric flow of service waste containing very little radioactivity. The PEW condensate was itself of variable composition, depending largely on the particular processes being conducted at INTEC during that month. For example, facility decontamination activities following a fuel reprocessing campaign would be expected to release fission products to the PEW condensate, including Sr-90 and 1-129. However, because of the complex operational history of INTEC, it is difficult to determine the exact cause of each of the many activity peaks observed in service waste composition time-series plots.

There appears to be little temporal correlation between the observed pulses for tritium, Sr-90, and 1-129. This is not surprising considering the difference in the behavior of these three radionuclides during spent fuel reprocessing. Although Sr-90 and 1-129 are both fission products derived from spent fuel dissolution, these two elements became separated from one another as a result of their differing physico-chemical properties. For example, iodine is quite volatile, but strontium is not. This difference in volatility resulted in more carryover of 1-129 across the PEW evaporator as compared to Sr-90.

4. INJECTION WELL 1-129 SOURCE TERM

With respect to the former INTEC injection well, 1-129 has become the primary focus of concern among the regulatory agencies because of its long half-life. The maximum contaminant level (MCL) is 1 pCi/L. Because 1-129 data for the service waste are only available since 1976, it has been necessary to estimate the quantity of 1-129 that went to the injection well prior to 1976. Such an estimate was made during the groundwater modeling performed for the RI/BRA (DOE-ID 1997, Appendix F). The approach taken at that time was to calculate the average monthly 1-129 discharge to the injection well over the period for which records exist (1976 to 1985). The monthly average 1-129 discharge over the period of record was calculated to be 3.57 mCi/month. This value was then assumed to apply to the earlier period for which no 1-129 records exist (1953 to 1976). The total 1-129 inventory sent to the injection well during its lifetime was then estimated to be 1.39 Ci (DOE-ID 1997, Appendix F). The groundwater modeling performed during the RI/BRA then used these values to model the injection well 1-129 source.

The previous estimate of the total amount of 1-129 assumed to have been discharged to the injection well during its operation are believed to be too high because

- Groundwater monitoring results (Beasley, Dixon, and Mann 1998) show far less 1-129 present in groundwater than the 1.39 Ci of 1-129 that was assumed to have been discharged to the injection well during the RI/BRA modeling.

- Previous estimates were based on averaging the 1-129 activity in service wastewater over the period for which records were available, but this period includes a time during 1978-79 when I-129 releases to service waste were much higher than normal.

- Process knowledge indicates that prior to startup of the Waste Calcining Facility (WCF) in 1963, most of the 1-129 released during spent fuel reprocessing would have accumulated in the high-level liquid wastes stored at the tank farm. Therefore, previous estimates of 1-129 releases to the injection well for the years 1953 to 1963 were much too high.

Based on the above, another evaluation of 1-129 discharges to the injection well was performed. This approach to this problem and the results of the revised injection well 1-129 source assessment are presented below, with additional details included in Appendix C. The results of this assessment show that the amount of 1-129 previously assumed to have been discharged to the injection well during its operation was approximately 40% too high. A revised estimate of the total amount of 1-129 discharged to the injection well indicates a total of approximately 0.86 Ci (as opposed to the previous estimate of 1.39 Ci).

As a fission product, the 1-129 present at INTEC is entirely attributable to its liberation during dissolution of the spent fuel during reprocessing. Essentially all of the 1-129 was present within the spent fuel brought to INTEC for processing; virtually no 1-129 was produced at INTEC. Therefore, it is possible to calculate the approximate total 1-129 inventory that has been present at INTEC based on the total quantity of spent fuel reprocessed. Cordes (1978) performed such an analysis using the "fissions processed" approach, along with the 1-129 fission yield. Using this approach, Cordes (1978) estimated that a total of approximately *5* Ci of 1-129 were present in the fuel processed between 1953 and 1977. Virtually all of this total would have been released to the first-cycle product during spent fuel dissolution. Following its liberation from the spent fuel, the 1-129 would have ended up at one of the following four destinations:

1. Temporary storage in tank farm liquid wastes
2. Atmospheric discharge from the main stack
3. Groundwater discharge of PEW to the injection well
4. Storage in solid calcine material in WCF bins.

McManus et al. (1982) performed a detailed study of the fate of 1-129 at INTEC and determined that the vast majority of the 1-129 was discharged to the atmosphere through the main stack (approximately 81%). A much lesser quantity of 1-129 went to the injection well (approximately 18%) and only a small quantity would have ended up in the solid waste (calcine) (approximately 1%).

McManus et al. (1982) also investigated the relationship between the plant processes and 1-129 activity in service waste. Among other findings, their study demonstrated that 1-129 releases from INTEC were related primarily to (1) WCF operation and (2) high-level liquid waste (HLLW) evaporator operation. When the WCF was operating, overall 1-129 discharges to both the atmosphere (via the main stack) and to service waste were higher. When the HLLW evaporator was operating, 1-129 activities in service waste increased by approximately a factor of 10, as compared to periods when the HLLW evaporator was not operating.

Appendix C includes historical information on WCF and HLLW evaporator operational periods and the correlation between operational status of these two facilities and 1-129 activities in service waste. Using this information, the total 1-129 activity discharged to the former injection well during its lifetime has been recalculated. These calculations are based on historical records of the operational status of the WCF (or New Waste Calcining Facility) and the HLLW evaporator, coupled with the observed 1-129 activities in the service waste during periods when the WCF and/or HLLW evaporator were operating (or not). Calculations indicate that a maximum of 0.86 Ci 1-129 were discharged to groundwater through the former injection well during its lifetime. This value is approximately 62% of the previous estimate of 1.39 Ci 1-129 used in the Operable Unit (OU) 3-13 RI/BRA modeling. While the new estimate still appears too large based on the amount of 1-129 present in the aquifer, it nevertheless appears to be more realistic than the RI/BRA total 1-129 value. Appendix C details the calculations and assumptions, along with additional supporting information regarding the factors affecting the disposition of I-129 at INTEC during spent fuel reprocessing.

5. GROUNDWATER QUALITY NEAR FORMER INJECTION WELL

During its operation, the injection well was a known source of low-level radioactivity to the aquifer, and the primary radionuclides of environmental significance were tritium, Sr-90, and 1-129. For each of these three radionuclides, the groundwater plumes that have developed downgradient (south) of the injection well source have been well documented and delineated over the past 50 years by the United States Geological Survey (USGS) and the Idaho National Engineering and Environmental Laboratory (INEEL). Numerous reports have been prepared over the years by the USGS, INEEL, the State of Idaho INEEL Oversight Program, and others to summarize INEEL impacts to groundwater quality, including impacts from INTEC and the former injection well.

Under the Comprehensive Environmental Response, Compensation and Liability Act, the OU 3-13 Final Record of Decision established remedial action objectives (RAOs) for the INTEC-derived contaminant plume within the SRPA and outside the INTEC security fence (DOE-ID 1999). These RAOs are as follows:

1. Prior to 2095, prevent current on-Site workers and general public from ingesting SRPA groundwater that exceeds a cumulative carcinogenic risk of 1×10^{-4}, a total hazard index of 1, or applicable State of Idaho groundwater quality standards (i.e., maximum contaminant levels [MCLs])

2. In 2095 and beyond, ensure that SRPA groundwater does not exceed a cumulative carcinogenic risk of 1×10^{-4}; a total Hazard Index of 1; or applicable State of Idaho groundwater quality standards (i.e., MCLs).

RAO #1 is currently being achieved and maintained through the use of institutional controls (i.e., land use restrictions and INEEL security fence) to prevent access by the general public. To protect workers, water quality is monitored in drinking water supply wells. For risk assessment purposes, however, all institutional controls are assumed to end in the year 2095 (100 years after implementation of the Group 5 remedy). Compliance with drinking water MCLs is a more stringent requirement than compliance with the cumulative carcinogenic risk or total Hazard Index criteria. Therefore, RAO #2 requires that by the year 2095, groundwater within the INTEC-derived contaminant plume must not exceed drinking water MCLs for any of the contaminants of potential concern associated with past operations at INTEC.

The three COC radionuclides associated with past use of the injection well, along with their respective MCLs, are tritium (20,000 pCi/L), Sr-90 (**8** pCi/L), and 1-129 (1 pCi/L). Both groundwater monitoring and groundwater modeling are being used to assess hture water quality within the SRPA. Modeling results are presented elsewhere (DOE-ID 1997, 2002) and will not be discussed further here.

Existing groundwater data downgradient of INTEC were reviewed to assess whether RAO #2 will be achieved by 2095. Appendix D includes concentration trend plots for each of the three principal radionuclides in USGS monitor wells located near and downgradient of the former INTEC injection well.

It should be noted that most of the USGS monitor wells of interest have long open intervals from which groundwater samples are collected. Monitor well completion information is summarized elsewhere (DOE-ID 2003) but a typical USGS well is completed with an open hole through the basalt from approximately 450 to 650 ft in depth. Depths to groundwater are currently approximately 465 ft near the injection well.

To address possible dilution effects from sampling of USGS monitor wells that have long open intervals, depth-specific groundwater samples have been collected periodically over the years using a straddle packer or thief sampler. McCurry and Welhan (1996) performed such an investigation of several monitor wells close to INTEC during 1992-1994. More recently, depth-discrete groundwater samples were collected from above, within, and below the HI sedimentary interbed in four borings to determine whether elevated 1-129 levels were present downgradient of INTEC (DOE-ID 2002 and the Group 5 Monitoring Report/Decision Summary").None of the analytical results from these depth-specific groundwater samples collected from wells near INTEC have exceeded the 1-129 MCL of 1 pCi/L. Finally, during July-August 2003, groundwater samples were collected below the HI interbed using an inflatable packer at monitor Wells USGS-41, USGS-48, and USGS-59, as required in the Group 5 Long-Term Monitoring Plan (DOE-ID 2003). Iodine-129 concentrations in groundwater from beneath the HI interbed were less than the MCL (1.0 pCi/L) in all of the wells. Among the three wells, USGS-48 showed the highest 1-129 activity (0.25 ±0.05 pCi/L). USGS-48 is located approximately 950 ft downgradient of the former injection well, making it among the closest wells to Site CPP-23. The observation that the 1-129 concentration in groundwater beneath the HI interbed in this well is currently less than 50% of the MCL provides strong evidence that no significant residual deep source of 1-129 exists at the former injection well. Furthermore, tritium and Tc-99 activities were likewise far below their MCLs in each of the wells (900 pCi/L and 20,000 pCi/L, respectively). The highest tritium activity observed was 2,080 pCi/L (USGS-48), and the highest Tc-99 activity was 36.9 pCi/L (USGS-59). The only COC that exceeded the MCL below the HI interbed was Sr-90. Sr-90 activities were slightly above the MCL (8 pCi/L) in each of the three wells, with the highest Sr-90 activity reported for USGS-59 (9.91 ±1.49 pCi/L). However, Sr-90 concentrations in groundwater at and downgradient of INTEC have been steadily declining, and are predicted to decline below the MCL long before the year 2095.

In the past, the regulatory Agencies have expressed concern about the possibility that organic compounds may have been disposed to the former INTEC injection well. While it is possible that organic constituents were inadvertently discharged to the well upon occasion, there is no evidence that the injection well was ever used for routine disposal of organic constituents to groundwater. During injection well closure in 1989, groundwater samples were collected from INTEC water supply Well CPP-01 and nearby monitor Wells USGS-40 and 47. No organic compounds were detected, and all volatile organic compounds (VOCs) were below the 10-μg/L reporting limit.

Appendix D contains a summary of available VOC results for groundwater monitor wells near INTEC. Trace concentrations of 1,1,1-trichloroethane (TCA) have occasionally been detected in groundwater and perched water but the observed concentrations were more than 100-fold below drinking water MCLs. Based on both process knowledge and groundwater monitoring results, there is no evidence that the injection well was ever used for routine disposal of organic compounds, and there is no indication of any significant historical or existing source of VOCs in the vadose zone or groundwater near the former injection well.

a. "Monitoring Report/Decision Summary for Operable Unit 3-13, Group 5, Snake River Plain Aquifer" (report in progress; final version is to be released January 2004).

6. CONCLUSIONS

Groundwater monitoring results collected to date demonstrate the following:

- Tritium activities have declined below the drinking water MCL (20,000 pCi/L) in all nearby SRPA downgradient monitor wells (USGS-40 to USGS-49), but remain slightly above the MCL in a few perched water wells within the INTEC security fence (33-2, MW-17, USGS-50).

- Sr-90 activities in some SRPA monitor wells downgradient of the former injection well remain above the drinking water MCL (e.g., 45 pCi/L in Well USGS-47 in 2001). However, Sr-90 levels in perched wells closest to the former injection well (USGS-50, MW-I) are at or below the MCL (8 pCi/L), but some perched monitor wells close to the tank farm contain very high Sr-90 activities (e.g., 147,000 pCi/L Sr-90 in MW-2 in 2003). The distribution of Sr-90 strongly suggests that the primary source of Sr-90 in the perched water is contaminated soils in the vicinity of the tank farm, not the former injection well. The latter source will be addressed during the RI for OU 3-14.

- Iodine-129 activities have declined below the MCL (1 pCi/L) in all downgradient SRPA monitor wells and in all the nearby perched wells (USGS-50, MW-I). These data include vertical profile samples from discrete zones in four SRPA monitor wells and deep groundwater samples from four boreholes drilled through the HI sedimentary interbed.

- Given the low I-129 activities that currently exist in the aquifer, no evidence exists for a significant 1-129 source near the INTEC injection well. However, if such a source were to exist, the data indicate it is releasing its activity at a very slow rate and significant future increases in 1-129 activity in the groundwater are not likely.

- VOC concentrations in the aquifer at and downgradient of the former injection well are far below MCLs for all compounds; there is no evidence that the injection well ever constituted a significant source of VOCs or other organic compounds to the aquifer.

- Material remaining in the former injection well in 1989 at the time of well closure consisted of sloughed well filter pack material and interbed sediments, not “sludge” derived from the service waste.

In summary, tritium and 1-129 activities are already below their respective MCLs in the SRPA downgradient of INTEC, and no significant residual sources of tritium and 1-129 appear to exist at or near the former injection well. Sr-90 activities in the aquifer currently exceed the MCL downgradient of INTEC and vadose zone, and aquifer matrix materials near the tank farm appear to constitute a residual secondary source of Sr-90 to groundwater. However, Sr-90 concentrations are slowly declining in wells near and downgradient of INTEC, and groundwater quality trends indicate that Sr-90 activities in groundwater outside the INTEC security fence will decline below the MCL by 2095. Groundwater modeling being performed under OU 3-13, Group *5*, will provide estimates of hture Sr-90 concentrations in the aquifer. Elevated Sr-90 activities present in tank farm soils will be addressed under the RI for OU 3-14.

7. REFERENCES

Beasley, T.M., P. R. Dixon, and L. J. Mann, 1998, "^{99}Tc, ^{236}U, and ^{237}Np in the Snake River Plain Aquifer at the Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho," *Environmental Science & Technology, Vol. 32,* No. 24, pp. 3875-3881.

Cordes, Ormand L., Allied Chemical, to Jack T. Barraclough, USGS, April 18, 1978, "I-129 in Liquid and Airborne Effluents," Cord-53-78. [also see Appendix E of this document]

DOE-ID, 1978, *Recovery of ICPP from Criticality Event of October 17, 1978,* ACI-362, Allied Chemical Idaho Chemical Programs, November 1978.

DOE-ID, 1997, *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL-Part A, RI/BRA Report (Final),* DOEAD-10534, Rev. *0,* U.S. Department of Energy Idaho Operations Office, November 1997.

DOE-ID, 1999, *Final Record of Decision Idaho Nuclear Technology and Engineering Center, Operable Unit 3-13,* DOE/ID-10660, Rev. *0,* U.S. Department of Energy Idaho Operations Office, October 1999.

DOE-ID, 2002, *Plume Evaluation Field Sampling Plan for Operable Unit 3-13, Group 5, Snake River Plain Aquifer,* DOE/ID-10784, Rev. 2, U.S. Department of Energy Idaho Operations Office, July 2002.

DOE-ID, 2003, *Long-Term Monitoring Plan for Operable Unit 3-13, Group 5 Snake River Plain Aquifer,* DOE/ID-10783, Rev. 2, U.S. Department of Energy Idaho Operations Office, March 2003.

McCurry, Michael, and J.A. Welhan, 1996, "Summary of Analytical Results for Hydrologic Studies of Wells Open Through Large Intervals of the Snake River Plain Aquifer at the Idaho National Engineering Laboratory," DOE Grant: DE-FG07-911D-13042, July 1996.

McManus, G.J., F.A. Duce, S.J. Fernandez, and L.P. Murphy, 1982, *A model of iodine-129 process distributions in a nuclear fuel reprocessing plant,* ENICO-1108, Exxon Nuclear Idaho Company, Inc., April 1982.

Appendix A

History of the INTEC Injection Well

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EXECUTIVE SUMMARY

The former Idaho Nuclear Technology and Engineering Center (INTEC) injection well, located north of Building CPP-666, was used to routinely discharge service wastewater to the Snake River Plain Aquifer (SRPA) from 1952 to February 1984. The injection well has been referred to as Well CPP-03, as Well MEH-FE-PL-304, and by its Federal Facility Agreement and Consent Order (FFNCO) site designation, CPP-23. The injection well was drilled during 1950-51, and, beginning in 1952, the well received an average of 1 million gallons per day (MGD) of service wastewater consisting of plant cooling water, demineralizer and boiler blowdown water, and process equipment waste (PEW) evaporator condensates. On February 7, 1984, the injection well was taken out of routine service, and Percolation Ponds 1 and 2 located south of the INTEC facility began receiving the service waste stream. Small amounts of service waste were intermittently disposed of at the injection well during 1984 to 1986, with no use of the well after 1986. The injection well was pressure-grouted with cement and abandoned in October of 1989. Further investigation of the injection well as a source of contamination to the SRPA has been performed through the FFNCO. This paper is an attempt to pull together known historical information regarding the construction, reconstruction, and use of the injection well in support of the FFNCO investigation of the injection well.

Two major well reconstruction efforts were conducted during the operational lifetime of the INTEC injection well. The first reconstruction took place during the fall of 1970 and spring of 1971 upon discovering the injection well was blocked at 226 ft below land surface (bls). The injection well continued to receive service waste during this reconstruction effort, and emergency discharge lines that had been routed to United States Geological Survey (USGS) Wells USGS-47 and USGS-48 were never used. The injection well was cleaned to a depth of 596 ft below land surface (bls) and a 9-7/8411. inner diameter polyvinyl chloride (PVC) liner was installed at the conclusion of the 1970-71 reconstruction. In September 1981, the well was again found to be blocked, at a depth of 534 ft bls, and the liner found to be completely collapsed at a depth of 435 ft bls in July 1982. The service waste stream was diverted to a gravel pit located east of INTEC during this reconstruction effort. The well was cleaned to a depth of 585 ft bls during this reconstruction, but sand and silt (formation material) continued to flow into the well throughout this effort. Sand was repeatedly bailed from the well and pumped to the gravel pit east of INTEC and was later boxed and shipped to the Radioactive Waste Management Complex (RWMC) for burial. Efforts to locate information regarding the total volume and any characterization data for the sand have been unsuccesshl. At the conclusion of the 1982 reconstruction effort, a 10-in.-diameter polyethylene liner was placed in the well to a depth of 560 ft.

The service wastewater discharged to the injection well contained radionuclides, including tritium (H-3), strontium-90 (Sr-90), cesium-137 (Cs-137), and iodine-129 (1-129). The wastewater also contained minor amounts of various other chemical constituents. Organic constituents were an insignificant component of the service waste. Even though the PEW liquid waste stream carries the F001, F002, F005, and U134 U.S. Environmental Protection Agency (EPA) hazardous waste numbers; these hazardous waste numbers were

assigned to PEW evaporator condensates through application of the “derived from” rule. Suspended solids are also insignificant in the service waste stream, based upon knowledge of the processes that contributed to the service waste stream and limited analytical data.

When the injection well was grouted and abandoned in 1989 at the direction of the State of Idaho, the well contained sloughed material below a depth of 475 ft bls. This material is composed of well construction and formation material, as becomes evident upon review of the 1970-71 and 1981-82 reconstruction activities and service waste composition. Although the injection well was a significant source of contaminants to the SRPA during its operation, it is highly unlikely that the plugged well constitutes a continuing source of contamination to the SRPA.

CONTENTS

FIGURES

TABLES

ACRONYMS

bls	below land surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFA	Central Facilities Area
CPP	Chemical Processing Plant (designation for buildings and areas at INTEC)
EINCO	Exxon Idaho Nuclear Company, Incorporated
EPA	Environmental Protection Agency
FAST	Fluorinel Dissolution and Storage Facility
FFA/CO	Federal Facility Agreement and Consent Order
HDPE	high-density polyethylene
ICPP	Idaho Chemical Processing Plant (now INTEC)
ID	inside diameter
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LDU	land disposal unit
LET&D	Liquid Effluent Treatment and Disposal (facility)
MGD	million gallons per day
NWCF	New Waste Calcining Facility
OD	outside diameter
PEW	process equipment waste
PVC	polyvinyl chloride
RAL	Remote Analytical Laboratory
RCRA	Resource Conservation and Recovery Act
RWMC	Radioactive Waste Management Complex
RWMIS	Radioactive Waste Management Information System
SRPA	Snake River Plain Aquifer

TAN	Test Area North
TCLP	toxicity characteristic leaching procedure
TSS	total suspended solids
WCF	Waste Calcining Facility
WINCO	Westinghouse Idaho Nuclear Company, Incorporated
USGS	United States Geological Survey

A-I. INTRODUCTION

Processes at the Idaho Nuclear Technology and Engineering Center (INTEC) have generated large volumes of service wastewater, including plant cooling waters, demineralizer and boiler blowdown, and process equipment waste condensates. The INTEC injection well, located north of Building CPP-666, was used to discharge the service wastewater to the aquifer from 1952 to February 1984. The injection well has been referred to as Well CPP-03, as Well MEH-FE-PL-304, and by its Federal Facility Agreement and Consent Order (FFA/CO) Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) site designation, CPP-23 (land disposal unit).

On February 7, 1984, the injection well was taken out of routine service, and wastewater was pumped from two parallel collection vaults to Percolation Ponds 1 and 2 located south of the INTEC facility. Disposal of wastewater to the injection well was very limited after the use of the Percolation Ponds began. Minor amounts of wastewater were discharged to the injection well in 1986. No wastewater was discharged to the well after that year. The well was plugged with cement grout in October of 1989 (DOE-ID 1997; WINCO 1990). Details of the well construction and maintenance history are provided in Section A-2. Section A-3 summarizes information on the composition of wastewater discharged to the well during its operation, and Section A-4 discusses the origin of material remaining in the injection well at the time it was plugged in 1989.

A-2. INJECTION WELL CONSTRUCTION HISTORY

A-2.1 1950 Drilling

Cable tool drilling began on Well CPP-03 on September 3, 1950, by the R.J. Strausser Drilling Company of Portland, Oregon[b]. During a phone conversation with Idaho Nuclear Company personnel in 1970, Mr. Strausser explained that the well was originally intended to have been a water production well (Micum, 1971a, Daily Log for 10/23/70). The borehole had been advanced to a depth of 212 ft below land surface (bls) by September 20, 1950, at which time a determination was made to terminate drilling on this borehole, as it was not a good location for a production well, and to move the drill rig to another location. The borehole was then filled with gravel to 20 ft below land surface and all but the upper 20 ft of steel surface casing was removed. The drill rig was moved off of the borehole on September 25, 1950. No mention is made in the drillers log as to the size of the borehole diameter although the drillers log states that 20 ft of "starter casing" was left in place in order to prevent the caving of surficial sediments into the hole as the borehole was abandoned. Additionally, the log states that this was done in order to prevent the drill rig from falling into the hole. Records from later work in this well show that this "starter casing" was 20-in.-diameter pipe (Strausser 1950).

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b. The as-built drawn by the USGS sometime after well construction and a USGS memo by H. G. Sisco in September of 1951 show the R.J. Strausser Drilling Company as being located in Portland, Oregon. However, the logbooks for the 1970/1971 reconstruction of the injection well indicate that the R.J. Strausser Drilling Company was located in Burley, Idaho. The reconstruction logbook indicates that several conference calls were made to Mr. Strausser in Burley, Idaho, during the 1970/1971 reconstruction.

c. The driller referred to this as "starter pipe." He left it in the ground to control caving around the rig as considerable subsidence was occurring.

A-3. 1951 DRILLING

The R.J. Strausser Drilling Company continued drilling on Well CPP-03 beginning on June 8, 1951, for the purpose of completing it as an injection well. The total depth of 598 ft below land surface was reached on August 25, 1951. Considerable difficulty was encountered during drilling in the 270-ft to 320-ft bls zones.[d]

During a conference telephone call on November 2, 1970, Mr. Strausser explained that cement grout had been placed into the well at the depths where "redrilled well" is indicated. He further stated that the driller had gathered up all the loose scrap iron around the drill site and "dropped it down the well with the concrete" in the intervals where "iron" is listed in the log (Micum, 1971a, Daily Log for 11/2/70). Scrap iron was apparently utilized at that time to assist in advancing boreholes when using a cable tool drilling rig.

No borehole diameter is listed in the 1950 or 1951 driller's logs. Several as-built well drawings drawn by the USGS at a later date show the borehole to be 24 in. in diameter. No mention is made of the 20-in.-diameter "starter casing." Caliper logging conducted during the 1970 reconstruction clearly shows the 20-in.-diameter surface casing extending to the bottom of the alluvium at 41 ft bls. The caliper log also shows a 20-in. casing or borehole diameter to at least 90 ft bls where remnants of the 16-in. casing began (Barraclough 1970 and Micum 1971a, construction diagrams). The caliper log also shows 20-in.-diameter hole through "hard basalt" at deeper depths once the 16-in. casing was removed. Mr. Strausser stated that the 20-in. casing had been used as surface casing and that the well had been advanced below the casing as a 20-in.-diameter borehole. Mr. Strausser could not explain how or why the USGS logs indicated a 24-in.-diameter borehole[e] (Micum 1971, Daily Log for 11/2/70). The USGS stated in 1971 that they did not have the original construction logs for the injection well. They reported that all original logs were abstracted, summarized, and then "retired." The summarized logs describe the borehole lithology with depth but provide very limited data on drilling method, drilling problems, or construction (Gildersleeve 1971).

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d. The following excerpts are from the drillers logs (Strausser, 1951):

1. 6/20/51 Shot hole (using dynamite) from 270 to 279 and backfilled to 278,
2. 6/21/51 Shot hole and redrilled from 280 to 281,
3. 6/22/51 Shot hole and redrilled from 281 to 283,
4. 6/23/51 Redrilled hole from 283 to 286,
5. 6/25/51 Cleaned out hole from 287 to 290,
6. 6/28/51 Redrilled hole from 295 to 297 Shot hole three times,
7. 6/29/51 Redrilled hole from 297 to 301 Shot hole twice,
8. 6/30/51 Redrilled hole from 301 to 306 Shot hole once,
9. 7/3/51 Shot good hole at 310 with 90 sticks 60% (dynamite),
10. 7/7/51 310-311 ft. Drilled up 100 lbs iron,
11. 7/9/51 312-313 ft. Drilled up 150 lbs iron,
12. 7/10/51 313-314 ft. Drilled up 100 lbs iron,
13. 7/11/51 313-315 ft. Drilledup 150 lbs iron,
14. 7/12/51 Shot hole 313 to 315,
15. 7/13/51 316-318 ft. Drilled up 50 lbs iron,
16. 7/14/51 318-321 ft. Drilledup 50 lbs iron,
17. 7/16/51 321-322 ft. Drilledup 50 lbs iron.

e. It would be impossible to drill a hole larger than 20 in. below a 20-in.-diameter casing with a cable tool drill rig. Therefore, the construction diagrams presented here show a 24-in.-diameter borehole through the alluvium with a 20-in.-diameter surface casing. The borehole diameter in the bedrock (below the 20-in. surface casing) is believed to be 20 in. in diameter.

One foot of cement grout was placed in the bottom of the well and then 15-7/8-in.-outside-diameter, 5/16-in.-wall-thickness carbon steel casing was installed from the bottom of the well to 2 ft above land surface. The annular space from the cement plug at 597 ft bls to 400 ft bls was filled with gravel that is less than 1-1/2 in. in diameter. The annular space from 400 ft bls to the land surface was filled with pit-run gravel.

The casing was perforated from 593 ft bls to 490 ft bls. A decision was made to perforate an additional section of casing after performing a water injection test on September 27, 1951. An additional 40 ft of casing was perforated at a depth of 452 ft bls to 412 ft bls.

Figure A-1 shows the most likely as-built well condition at the end of construction in 1951 given the conflicting existing information.

A-4. 1969 INTAKE VAULT CONSTRUCTION

The earliest well construction as-built drawings show the 15-7/8-in.-diameter well casing extending from 598 ft bls to the ground surface (USGS 1951). A construction diagram shows a “well pit” with a depth of 15 ft below surface in 1956 (Nace et al. 1956). It is likely that the driller left the well in the condition shown on the USGS diagrams and that the well pit was added sometime before the facility began “hot” operations in 1953. Photos taken in late 1969 and early 1970 show construction of the “current” 21-ft-deep injection well vault. The actual construction records for this activity have not been located. However, several as-built diagrams and construction photos clearly show the structure and dimensions of the vault.

The specifics of piping entering the vault and injection well are described in Section A-4.7.

A-4.1 1970 Inspection

The USGS and the Findlay Well Drilling Company conducted geophysical and video logging of the CPP-03 well between June 12 and June 15, 1970. The caliper log[f] shows that the 15-7/8-in.-diameter casing (hereafter referred to as “16-in.’’ for simplicity) was missing from the bottom of the vault at 21 ft bls to 90 ft bls (Barraclough 1970). Earlier USGS caliper logs taken in 1968 show that the 16-in.-diameter casing had already corroded away to a depth of 90 ft at that time but indicated that the well was still open to its total drilled depth (Gildersleeve 1971; Robertson et al. 1974).

The 16-in.-diameter casing was also found to be corroded through at 102 to 107 ft, 126 to 138 ft, 182 to 202 ft, and 205 to 226 ft bls. The well was blocked at a depth of 226 ft bls. The static water level within the well was found to be 193 to 200 ft bls when a flow of 500 gallons per minute (gpm) was injected into the well (normal flow rate), indicating that discharge was occurring into the vadose zone. When flow was reduced to 50 gpm the static water level dropped to 210 ft over a period of 17 minutes (Barraclough 1970).

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f. The caliper tool indicated that the hole diameter below the vault was 19-3/4 in. This may indicate that the hole had been cased with 20-in.-diameter casing to at least 90 ft bls or that the borehole had been drilled to an approximate 20-in.-diameter size. The use of 20-in.-diameter “starter casing” in 1951 likely indicates that the actual borehole diameter within the basalt below that “starter casing” was approximately 20 in. This then indicates that the borehole through the alluvium was a 24-in.-diameter borehole, 20-in. surface casing was placed to the top of the basalt, and then a 20-in.-diameter borehole was advanced to the total depth of 598 ft.

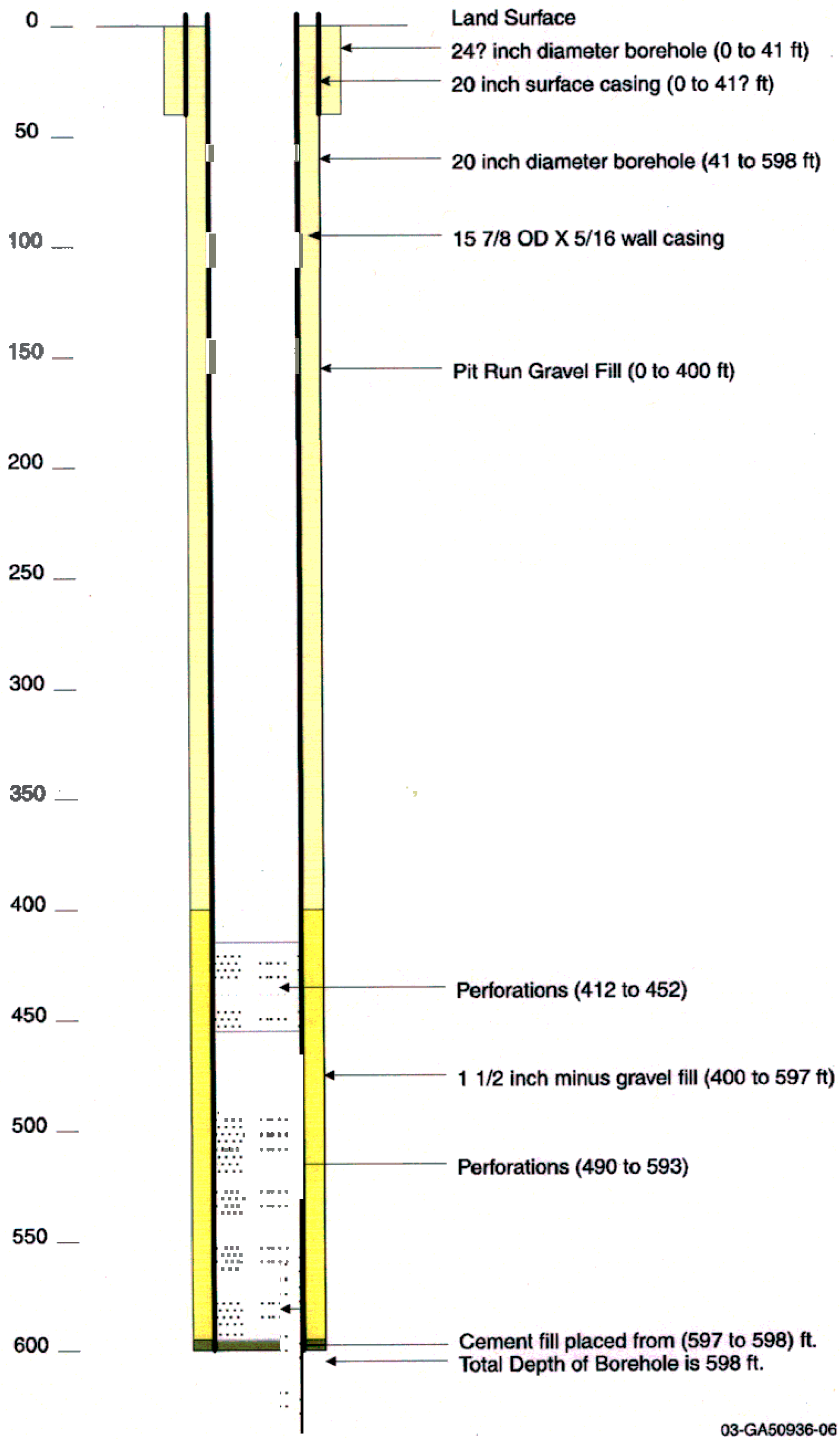

Figure A-1. Most likely as-built condition of the injection well after construction in 1951.

The Findlay Well Drilling Company cleaned the well from 226 ft to 271 ft bls by June 17, 1970. Materials removed from the well during this cleaning included red and brown clay, gravel, steel casing fragments, and corrosion products of rust and rusty pipe (Gildersleeve 1971).

A-4.2 1970 and 1971 Reconstruction

Well reconstruction took place from August 17, 1970, to April 14, 1971. Cleaning of the well began with the mobilization of a propane-powered 28 L Bucyrus Erie cable tool rig onto the site on August 17, 1970. Aluminum irrigation pipe (6- and 8-in.-diameter) was installed from the injection well to two USGS wells (USGS-47 and USGS-48) in the event that emergency discharge to these wells was necessary. However, the emergency pipeline was never used, and the injection well continued to accept the service waste stream during the reconstruction period.

Cleaning of the borehole began with the removal of the badly corroded 16-in.-diameter casing utilizing a casing spear. Cleaning was then attempted with the advancement of a 12-in.-diameter temporary casing after the removal of the 16-in. casing. Considerable difficulty in cleaning was encountered due to gravel slough entering the well from the surficial alluvium zone. The sloughing of surficial gravels was due to corrosion of holes through the 20-in.-diameter surface casing. A temporary 1/4-in.-wall, 18-in.-diameter casing was then installed to 58 ft bls in an attempt to limit the caving from the surficial sediment zone. The 12-in.-diameter temporary casing was then advanced to 499 ft bls, with cleaning of the well progressing to 566 ft bls by October 2, 1970.

Substantial material from the 140-to-170-ft bls interbed was found to be sloughing into the borehole from behind the 12-in.-diameter temporary casing. The 12-in. casing could not be advanced any deeper into the well due to slough material bridging behind the casing. The 12-in.-diameter casing was removed from the well on October 7, 1970, by applying 60,000 lb of pullback force in order to let the slough "pass." The well filled with caved material to 109 ft bls after the removal of the 12-in. casing. A 17-1/2-in. bit was then used to clean the borehole of the slough material and any remnants of the 1951 completion 16-in.-diameter casing. The temporary 18-in. steel casing was advanced behind the bit as the well cleaning progressed deeper. The 18 in.-casing was advanced to a total depth of 181.9 ft bls in an attempt to reduce the caving of material from the 140-to-170-ft interbed[g]. The 18-in. casing was hung from brackets placed on the floor of the injection wall vault in order to allow the continued use of the injection well during the work-over. The service wastewater was directed down the 18-in.-diameter casing.

Considerable difficulty was encountered in drilling from 270 to 325 ft in depth during October and November 1970. Concrete, iron, and grout continued to cave into the well from this zone. The borehole was so oversized in diameter through this section that it allowed the 10-in.-diameter bailer and the 17-1/2411. bit to pass each other in the borehole. Review of the original drillers log for this portion of the borehole shows considerable redrilling, blasting, and the addition of "iron" to the fill material. The log entries are included in Section A-2. Drilling proceeded slowly due to the large amount of iron and concrete sloughing into the borehole from this oversized portion.

g. The last five sections (approximately 100 ft) of 18-in.-diameter pipe placed into the well had a wall thickness of 5/16 in. This **is not relevant to final construction diagrams as this 18-in. casing was later removed.**

The lack of fine material in the slough made it difficult to pick up the material with the downhole bailer. A total of several hundred pounds of bentonite and 10 yd^3 of clay hauled from near Test Area North (TAN) were added to the well during October and November 1970 in an attempt to provide enough fine material to make mud and facilitate the removal of the slough material.

A 16-in.-diameter casing was advanced to refusal at 320 ft bls on November 30 in an attempt to reduce the caving from the oversized hole from 270 to 320 ft bls. The injection well wastewater was directed into the annular space between the 16- and 18-in.-diameter casings. The bottom 20 ft of 16-in. casing had a wall thickness of 0.375 in., and the remaining 16-in. casing had a wall thickness of 0.219 in.

A temporary 12-3/4-in.-outside-diameter steel casing was advanced on December 16, 1970, to refusal at 490 ft bls. The borehole was cleaned to 594 ft bls by January 13, 1971. Caving grout and sand behind the 12-in.-diameter temporary casing caused difficulties during the removal of the temporary casing from the well on January 13, 1971. After removal of the 12-in. casing, red sand and grout caved into the well on January 19, filling the well below 553 ft bls.

The well was then cleaned to a depth of 596 ft bls (within 1 ft of the cement plug at 597 ft) and 9-7/8-in.-inside-diameter polyvinyl chloride (PVC) plastic pipe was installed into the well to a depth of 596.4 ft bls. The PVC was reported to have 11-3/4-in.-outside-diameter couplings with the bottom 120 ft perforated. The size of the perforations was not found in the reconstruction log books. Twenty cubic yards of "concrete aggregate" were procured from a stockpile at the Central Facilities Area (CFA) for use in gravel packing outside of the PVC liner. The PVC pipe severed and/or collapsed during filling of the annular space on January 27. The collapse may have been caused by the addition of the gravel pack or the hydrostatic pressure caused by the injection well wastewater being placed in the annular space outside of the PVC. The top of the gravel fill within the well borehole was measured at 375 ft bls after the collapse.

The remaining 375 ft of intact PVC were removed from the well and placed into storage for future use. The PVC and gravel fill were then removed from the borehole to a depth of 588 ft bls, and the collapsed PVC and gravel fill were left in the well from 588 ft bls to the bottom of the well at 596.4 ft. The 12-in.-diameter steel casing with a 0.330-in. wall thickness was once again placed into the borehole, this time to the depth of 588 ft bls.[h] The 12-in. casing was perforated from 440 to 450, 475 to 510, 530 to 574 ft with four to eight perforations / ft.[i] A 1-in.-diameter steel water measuring line was placed to a depth of 446 ft. The measuring line was placed between the new 16-in. (1/4-in. wall thickness) steel casing and the 12-in.-diameter steel casing. The annular space behind the 12-in. casing was filled with 1-1/2-in.-maximum and 1/4-in.-minimum-diameter gravel from 588 ft to 182 ft bls. The 18-in.-diameter temporary casing was removed from the well and the annular space was filled with reject sand and pit run gravel from the CFA gravel pit. Approximately 150 yd^3 of sand and gravel were used to fill the annular space behind the 12-in. casing. Well reconstruction was completed April 14, 1971 (Micum 1971a).

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h. This was the third time that this casing had been placed into the well. Considerable discussions appear to have taken place regarding the use of this used pipe or the purchase of new pipe.

i. Perforation schedule located in Micum 1971a as a handwritten note to "Blaine" dated 3/9/71. Perforation **of** casing recorded on daily log for 3/10/71 (Micum 1971b)

A-4.3 1971 Liner Installation

An additional contract was issued to install a PVC liner into the well in August of 1971 during a general facility shutdown. The purpose of performing this work during the shutdown was to eliminate the wastewater entering the injection well and therefore reduce the problem of hydrostatic pressure on the outside of the PVC casing. The limited amount of service wastewater generated from the facility during the plant shutdown was directed to perched zone monitor well USGS-50 (Amberson 1971).

The driller arrived onsite on August 16, 1970, and cleaned approximately 1 ft of gravel and rust from the inside of the 12-in. casing. The 350 ft of intact PVC from the previous installation was reused with the addition of another 233-1/2 ft of new pipe. The PVC liner was installed with perforations from 448 to 588 and 411 to 415 ft bls (Micum 1971c). Figure A-2 shows the as-built well condition at the end of construction in 1971.

A-4.4 1981/1982 Inspections

The USGS conducted a caliper log of Well CPP-03 on September 17, 1981. The caliper log indicated that the well was bridged or filled to 534 ft bls. The log also shows that the PVC liner had a "rough" condition from 22 to 80 ft, a smooth section from 80 to 180 Å, rough from 180 to 220 ft, and alternating smooth and rough from 220 to 385 ft. The liner was smooth from 385 to 460 ft, rough from 460 to 480 ft, and smooth from 480 to 534 ft. The **USGS** reported that they believed the PVC liner was deteriorating.

A caliper log was run again on July 8, 1982. The caliper log indicated that there was a separation in the PVC liner at 135 ft bls and that the liner had totally collapsed at approximately 435 ft bls (Barraclough 1982).

A-4.5 1982 Reconstruction

A second injection well reconstruction effort occurred in the fall of 1982. The reconstruction by McCabe Brothers drilling began on September 7, 1982. The injection well service waste stream was diverted to the gravel pit located east of the INTEC (FFA/CO Site CPP-37) through an 8-in.-diameter aluminum surface laid pipe.

Through the use of a drilling "spear," the drilling company was able to remove all of the PVC liner down to 190 ft bls. The remaining PVC could not be removed with the spear or "jars." A decision was made to drill out the remainder of the PVC. In order to drill the PVC, it was necessary to fill the well to the 190-ft level with gravel. The gravel was placed into the liner with 416 ft of 6-in.-diameter tremmie pipe. Drilling out of the PVC began on September 19, 1982. Drilling out of the PVC and gravel had progressed to 584 ft by October 9 (within 13 ft of the bottom). Video logging of the well on Monday, October 11, revealed that the well had filled with silty material back up to a depth of 555 ft bls. Additionally, the video revealed that nearly all perforations were filled with silt and holes were visible in the steel casing at 420 and 460 ft bls. The logbook states that most of the material that "silted" into the well at this time was plastic particles from the PVC. The borehole had sloughed in to a depth of 534 Å by October 13 despite continual cleaning.

Field radiation surveys conducted by the onsite Health Physics personnel indicated that the material being removed from the well had contact radiation levels of 300 to 500 counts per minute (cpm) with occasional radiation levels up to 3,000 cpm above background levels. One reading of 6,000 cpm was recorded on October 30.

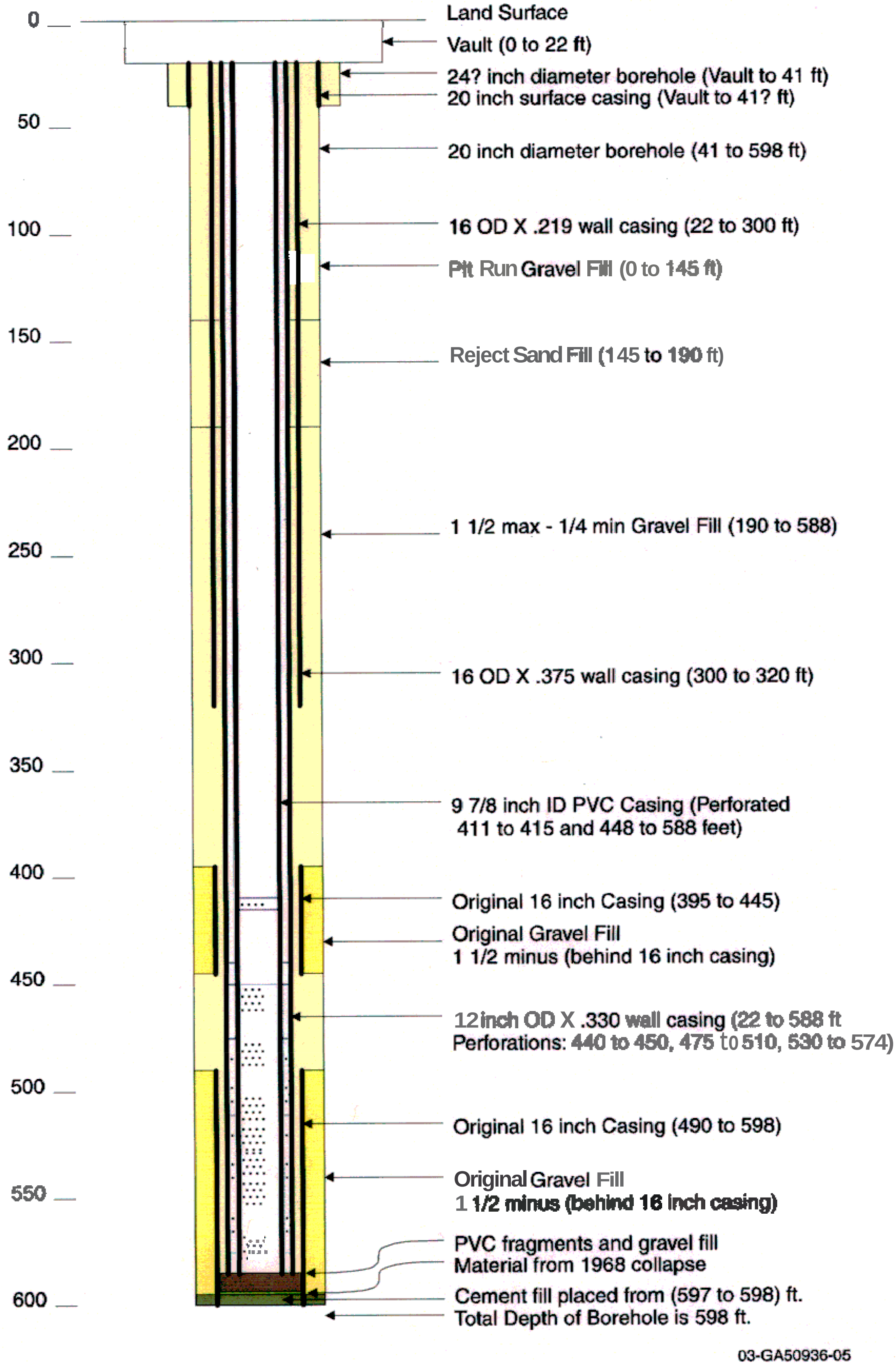


Figure A-2, As-built condition of the INTEC injection well *after* the 1971 reconstruction.

The holes in the 12-in.-diameter well casing were lined with 10-ft-long sections of casing sleeving. An additional 10 ft of sleeving fell to 500 ft bls during the sleeving operation. After the sleeving of the 12-in.-diameter casing, the well was cleaned to a depth of 585 ft. This depth is within 3 ft of the depth of the PVC fragments left in 1971. The casing was then perforated with three shots of explosive casing perforator cord. Each shot consisted of 25 ft of 50-grain/ft Detoprime (logbook spelling is unclear) explosive perforator. The logbook states that the shot cord perforations were placed at 470, 525, and 540 ft bls. It appears that this indicates the top of the 25-ft perforated zone. The shot bucket used to drop the explosive charges was forced to the bottom of the well and stuck at 584 ft bls.

Testing revealed that the well would not accept sufficient quantities of water after the explosive shot perforation. Therefore, a decision was made to gun-perforate a larger portion of the well casing. A gun perforator was lowered into the well and the casing was perforated with rows of 1/2-in.-diameter holes spaced 2 ft apart at 90 degree angles from each other. The casing was perforated with 136 holes from 510 to 565 ft and 160 holes from 470 to 510 ft on October 28,1982.

The well began filling with sand almost immediately after the gun perforating. The reconstruction logbook indicates that sand was bailed from the well, 24 hours a day, for 4 days with no progress made in deepening the well. A sand pump was then lowered into the well and sand slurry was pumped to the gravel pit east of the INTEC beginning on November 2 and ending on November 6. The bottom of the well was tagged at 560 ft bls following the sand pumping. The sand was later removed from the gravel pit, boxed, and then shipped to the Radioactive Waste Management Complex (RWMC) for burial. Efforts to locate analytical results for sand sent to RWMC have been unsuccesshl.

A 10-in.-diameter, 1-in.-wall-thickness, polyethylene liner was then placed in the well from 20 ft bls to a depth of 560 ft. The liner was high-density polyethylene (HDPE) plastic welded together on the surface by Catalytic Corporation and then run into the well in one piece. The liner was perforated with a 2-in.-diameter hole saw prior to installation in the well. Two holes were placed 180 degrees apart every foot with the sets of two holes also being staggered every foot by 90 degrees. The bottom 110 ft of the liner, 450 to 560 ft bls, were perforated. (Gibeault and Phillips 1982; Gibeault 1982; McCabe 1982). Figure A-3 shows the as-built well condition at the end of construction in 1982.

A-4.6 1989 Abandonment

The INTEC injection well was pressure-grouted from the 475-ft bls level to the bottom of the vault at 21 ft bls in October of 1989. The vault was then filled with gravel to within 2 ft of the surface. The remaining 2 ft were then filled with concrete. The material below 475 ft bls was believed to be silt and sand (formation material) that entered the well from outside the casing. Silt and sand entering the well are consistent with the well's history of repeated sloughing of formation material into the well.

Samples were collected from the surface of the sediment column by a USGS sample team prior to abandonment on August 31, 1989. The sampling effort took approximately 4 hours to complete due to the difficulty in retrieving material, over which time the sample material was left in a stainless steel sample bowl. Radiological smears and field screening of the sampled material revealed no field-detectable levels of radionuclides. The sampled material was composed of sand and silt less than 1/8 in. in diameter (Harmel 1989).

The material was analyzed by Enwright Environmental Consulting Laboratories, Inc. of Greenville, South Carolina. Analytical results from the sampling of the well sediment are presented in the "Closure Plan for Land Disposal Unit (LDU) CPP-23 Injection Well (MAH-FE-PL-304)" report (WINCO 1990). Three radionuclides were detected in the sediment sample: cesium-137 (100 pCi/g), europium-152 (3.8 pCi/g), and europium-154 (2.5 pCi/g).

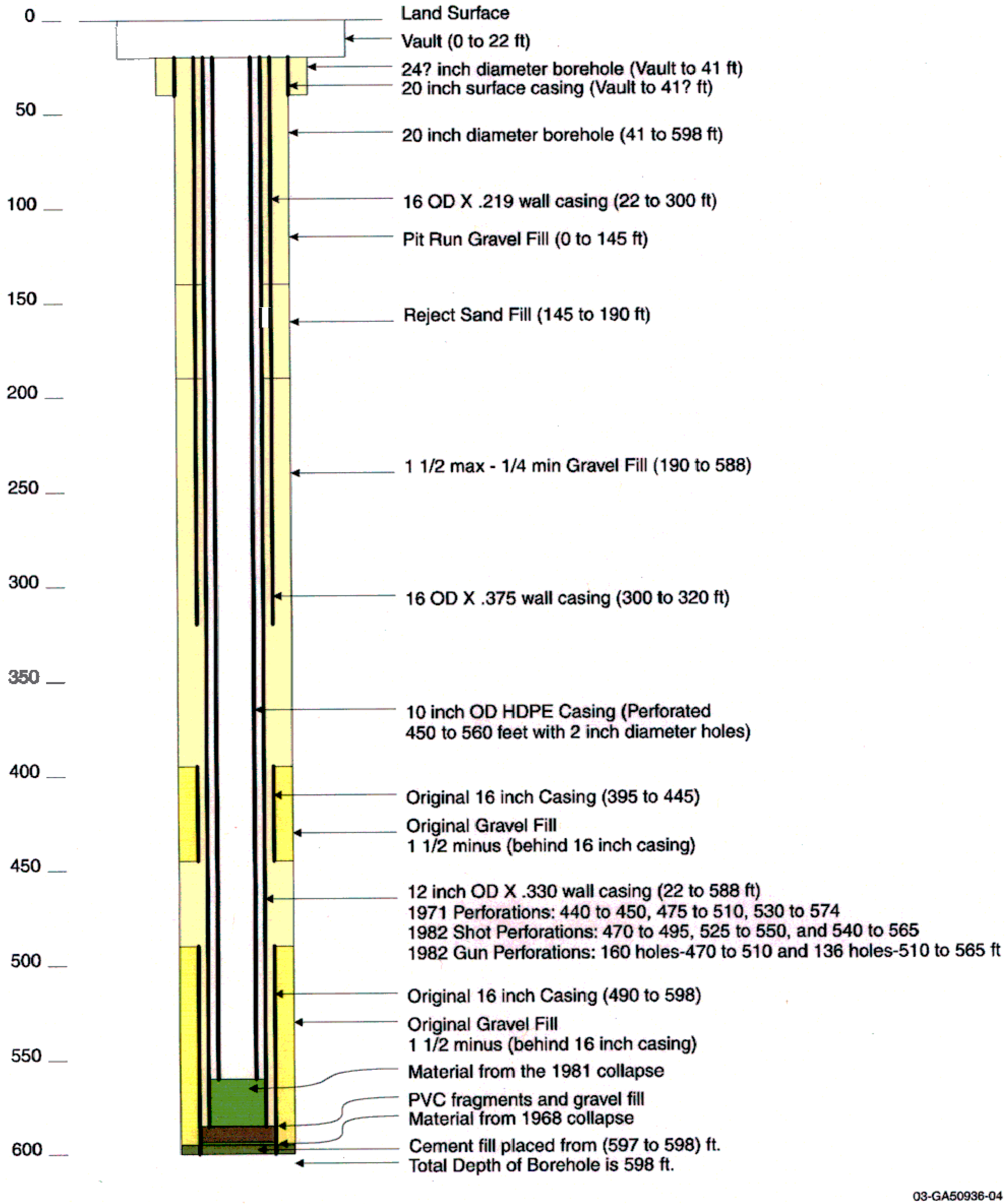


Figure A-3. As-built condition of the INTEC injection well after the 1982 reconstruction.

The extended sample collection time and mixing during sample collection called into question the validity of the volatile organic and mercury sample results. Additionally, the allowable holding time of

14 days for purgeable organic compounds was exceeded by 4 days at the analytical laboratory (Lane 1990) These discrepancies did not affect the validity of the other metals and radionuclide analysis.

A-4.6.1 East Side Waste

East side waste was collected in CPP-709 and then sent to the injection well through a variety of different pipes over the course of the injection well's use. East side waste originated in Buildings CPP-601, CPP-604, CPP-606, CPP-659 (New Waste Calcine Facility [NWCF]), CPP-633 (WCF), CPP-684 (Remote Analytical Laboratory [RAL]), and CPP-666 (Fluorine1Dissolution and Storage Facility [FAST]).

A-4.6.2 24-In. Clay Tile Line

The original line to the injection well was a 24-in-diameter clay tile line from CPP-709 to the injection well that was constructed in 1951. This line served as a backup line to a new 10-in. line after 1965 and was abandoned in 1983 (see Section A-4.6.3). The 24-in. clay tile line has been approximately 20% removed and approximately 80% filled with concrete for stability (WINCO 1991).

A-4.6.3 IO-In. Pipe

A 10-in.-diameter line was placed in service in the early 1960s and removed from service in 1983. This line connected the vault at CPP-709 to the injection well. The line has been approximately *5%* removed, approximately 10% abandoned in place, and approximately 85% filled with cement (WINCO 1991).

A-4.6.4 20-in. Fiberglass Reinforced Plastic

A 20-in.-diameter reinforced plastic line was installed between CPP-709 and the injection well in 1983 to replace the 24-in. and 10-in. service waste lines.

A-4.6.5 West Side Waste

West side waste was collected in CPP-734 before being sent to the injection well. West side waste originated in Buildings CPP-603, CPP-637, CPP-640, and CPP-687.

A-4.7 Construction History Discrepancies

Discrepancies existed within the various historical records regarding some aspects of INTEC injection well construction specifics. The most notable discrepancies and explanations are discussed below.

A-4.7.1 Borehole Size

The borehole size of the INTEC injection well is shown in the INEEL comprehensive well survey and in several other reports as being 24 in. in diameter. The early USGS as-builts show the borehole as a 24-in. diameter but no original drillers construction logs or diagrams could be found. The original drilling logs state that a "starter casing" was placed into the borehole to stabilize the alluvium before drilling into the underlying basalts. It is clear that this casing was left in place after the drilling of 1950. It is difficult to visualize a hole drilled into the basalts any larger than the inside diameter of this "starter casing." If the 20-in.-diameter surface casing found in the well in 1971 is this referenced "starter casing," then the borehole size would be limited to approximately 20 in. in diameter. Additionally, Mr. Strausser, the original driller, stated that he drilled the well to a 20-in. diameter when asked specifically that question during a telephone conference call in 1971. (Strausser 1950, Micum 1971b)

The borehole below the surface casing to as deep as 320 ft was repeatedly measured during the 1971 reconstruction as 20 in. in diameter by caliper logging. It is possible, but unlikely, that this could be a second, unreported casing string within a 24-in. borehole. However, it is unlikely that this casing would remain intact while all other casings corroded.

Based on these two lines of evidence, it seems very likely that the actual borehole diameter within the basalts is 20 in. as depicted on the as-built diagrams prepared for this document.

A-4.7.2 Depth of HDPE Liner

The reconstruction logbook of 1982 lists the borehole depth prior to placement of the HDPE liner as 560 ft. The well depth was once again tagged as 560 ft after placing of the liner. However, the as-built well diagram Drawing 172090 dated March 22, 1989, (EG&G 1989) shows the depth to the bottom of the HDPE liner as 540 ft. The construction logbook for the 1982 reconstruction indicates that an additional 20 ft of liner were welded onto the liner string on November 7, 1982, shortly before installation into the well. This made a total HDPE liner length of 540 ft. The liner was then placed into the well with the top of the liner at the bottom of the 20-ft-deep well vault. The person who prepared the 1989 as-built diagram either missed the addition of the 20 ft of liner shortly before installation or failed to take into account that the top of the 540-ft-long liner was placed at 20 ft bls. Based on this evidence, the as-built diagrams in this document show the HDPE liner bottom at 560 ft bls. (Gibeault and Phillips 1982; Gibeault 1983)

A-4.7.3 Eighteen Inch Diameter Casing

The as-built well diagram Drawing 172090 dated March 22, 1989, (EG&G 1989) shows an 18-in.-diameter steel casing from the bottom of the injection vault to 182 ft bls. The 1971 notes and completion diagrams show this casing string as a temporary casing that was removed from the borehole on March 17, 1971. Additionally, the 1971 pay vouchers go into some detail describing the cost effects of this casing being contaminated upon its removal from the well. Based on this evidence, the as-built diagrams in this document show the 18-in.-diameter steel casing as having been removed from the well (Micum 1971a; Micum 1971b).

A-4.7.4 USGS-50

Several documents generated at a later date indicate that the service waste was injected into Well USGS-50 during the 1970 reconstruction effort. No evidence of this use of USGS-50 could be found in the construction documents. The waste stream was directed to the INTEC injection well during the entire reconstruction effort according to the reconstruction logs. This was quite problematic for the cleaning efforts and ultimately lead to the failure of the PVC liner as excessive hydrostatic pressures from the injection water being placed outside of the liner may have caused its collapse. Log book entries and pay vouchers indicate that two separate backup discharge lines were constructed for the 1971 reconstruction effort in the event that the injection well would fail to accept the waste stream. The 6-in. and 8-in. aluminum backup discharge lines were directed to USGS-47 and USGS-48 but apparently were never used (Micum 1971a; Micum 1971b). Service wastewater continued to be discharged to the injection well during the entire well reconstruction period. However, records do indicate that service wastewater was directed to USGS-50 for a brief time during the PVC liner installation in late August of 1971 (Amberson 1971). The plant operations were curtailed during this period to minimize the amount of water sent to USGS-50.

A-4.8 Construction Summary

The following list highlights the relevant construction steps that were conducted on the INTEC injection well from its initial drilling in 1950 to its abandonment in 1989:

- The well was drilled in 1950 to a depth of 212 ft and then backfilled with gravel. The 20-in.-diameter (nominal) surface casing was left in place.
- The well was completed in 1951 to a depth of 598 ft.
  - 16-in.-diameter steel casing was placed to the bottom of the well to 598 ft.
  - Cement was placed in the bottom of the well from 597 to 598 ft to seal the bottom of the 16-in. casing.
  - The casing was perforated from 412 to 452 ft and 490 to 593 ft.
- The well was reconstructed in the fall of 1970 and the spring of 1971.
  - 16-in.-diameter steel casing was placed in the well to 322 ft bls.
  - The well borehole was cleaned to a depth of 596.4 ft (0.6 ft of sediment remaining from the 1968 collapse).
  - 9-7/8-in.-inside-diameter PVC pipe was installed to 596.4 ft.
  - The PVC collapsed due to the hydrostatic pressure of injection water on the outside of the casing.
  - The upper 350 ft of PVC were removed from the well and salvaged for future use. The remaining PVC and “concrete aggregate” -sized gravel were removed to a depth of 588 ft (8.4 ft of PVC and gravel remaining).
  - 12-in. x .330-in.-wall-thickness steel casing was placed in the borehole to a depth of 588 ft. The 12-in. casing was perforated from 440 to 450, 475 to 510, 530 to 574 ft with four to eight perforations per ft.
  - Over 150 yd^3 of annular fill were placed back into the well annulus.
- A noncorrosive plastic liner was installed into the well in August of 1971.
  - The 350 ft of salvaged PVC and additional new PVC were installed to a depth of 588 ft.
  - The PVC liner was perforated from 411 to 415 and 448 to 588 ft bls.

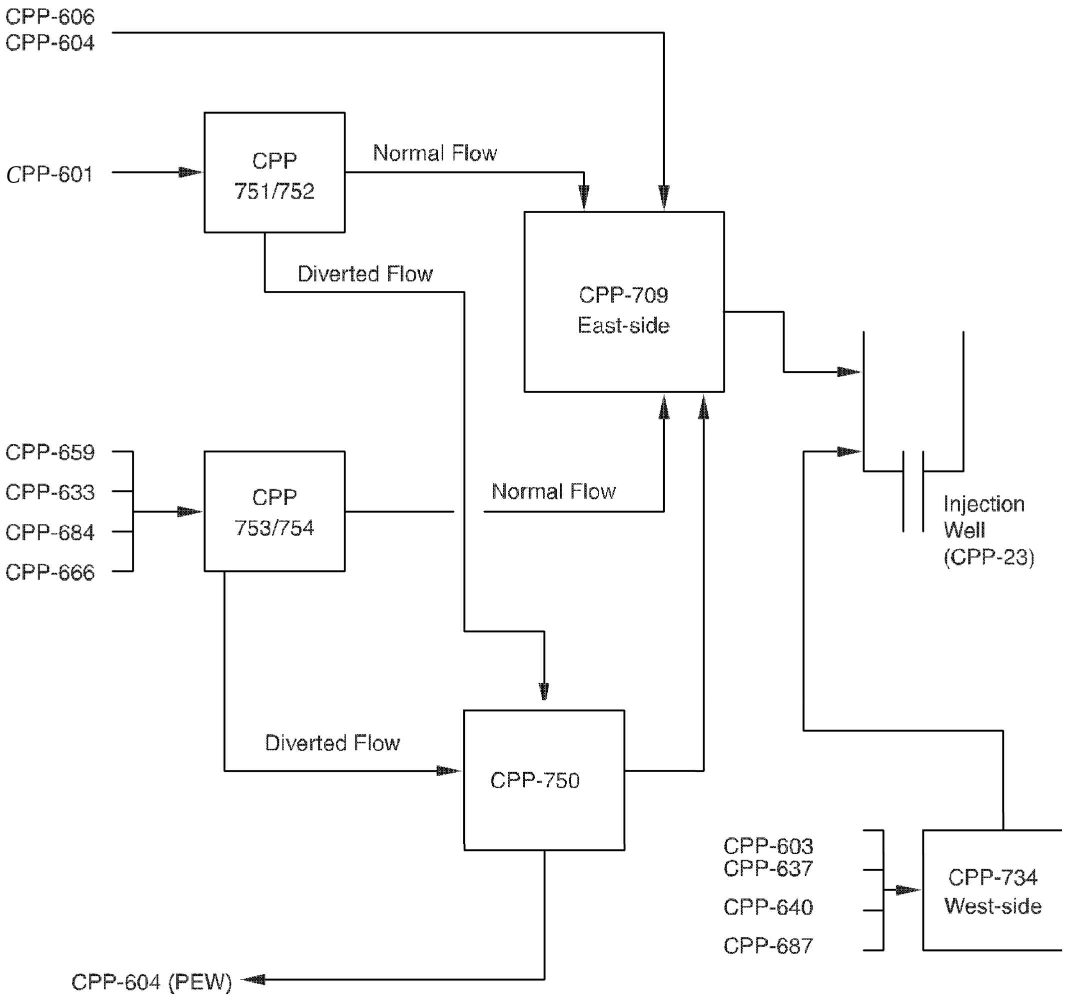
- The well was reconstructed in the fall of 1982.
  - The well was cleaned to a depth of 585 ft (3 ft of material remaining from the 1981 collapse).
  - Several corroded holes found in the 12-in.-diameter casing were repaired with steel liner sleeves.
  - The 12-in.-diameter casing was gun-perforated with 136 separate 1/2-in.-diameter holes from 510 to 565 ft and 160 holes from 470 to 510 ft.
  - A 10-in.-diameter HDPE liner with 1-in.-thick walls was placed from the bottom of the vault to 560 ft in depth. The HDPE liner was perforated with a 2-in.-diameter hole saw from 450 ft to 560 ft in depth.
- The injection well was taken out of routine service on February 7, 1984.
- The last use of the injection well occurred in 1986 (850 gal of service waste in 1986).
- The well was plugged by pressure-grouting in 1989.
- Sediments were present in the well below 475 ft in depth when the well was plugged.
- It is likely that the sediments found in the well in 1989 originated from sediments outside of the borehole entering the well through the 1/2-in.-diameter perforations in the 12-in. casing and 2-in.-diameter perforations within the HDPE liner. During the reconstruction of the well in 1982, it was observed that up to 50 ft of sediment had entered the well over single weekends. There is no evidence that this process of sand and silt heave would have stopped after the well was placed back into service.

A-5. INJECTION WELL WASTE STREAM

Wastewater from the INTEC was discharged to the injection well from the beginning of plant operations in 1954 through the discontinuation of the well in 1986. The waste stream was composed of service waste collected from various areas of the facility and sent via two collection systems to the well. Figure A-4 shows the generalized schematic of the east side and west side systems as well as the buildings and processes the systems served.

A-5.1 Injection Well Piping

Service waste was collected from several different areas of the INTEC and piped to the injection well for disposal. Figure A-4 graphically demonstrates the flow paths for waste generated at the facility and disposed to the injection well. A series of piping upgrades have been conducted since the first use of the injection well in September of 1952.



Key to Building shown in Figure A-4	
CPP-60 1	Fuel Process Building
CPP-603	Wet and Dry Fuel Storage Facility
CPP-604	Rare Gas Plant/Waste Building
CPP-606	Service Building Powerhouse
CPP-633	Waste Calcining Facility
CPP-637	Process Improvement Facility
CPP-640	Headend Process Plant
CPP-659	New Waste Calcine Facility
CPP-666	Fuel Dissolution Process/FAST Facility
CPP-684	Remote Analytical Lab
CPP-687	Coal-Fired Boiler House
CPP-709	Service Waste Monitoring Station
CPP-734	Service Waste Monitoring
CPP-750	Service Waste Diversion Pump Station
CPP-75 1	Service Waste Monitoring Station
CPP-752	Service Waste Diversion Station
CPP-753	Service Waste Monitoring Station
CPP-754	Service Waste Diversion Station

Figure A-4. Flow paths for service waste entering the injection well.

A-5.2 Chemistry of Wastewater

According to the Radioactive Waste Management Information System (RWMIS) database, it is estimated a total of 22,200 Ci (approximately 96% consisting of H-3) were discharged to the INTEC injection well during its operation. The total cumulative service wastewater flow into the well during this period was approximately 4.2 x 10^{10} L (1.1 x 10^{10} gal). This database provides a qualitative estimate of the activity and volume of wastewater discharged to the injection well. Based on drinking water standards, the major radionuclides of concern disposed to the injection well were H-3, Sr-90, Cs-137, and 1-129. Other short-lived radionuclides were also contained in the service waste, but the activities of these have declined to very low levels as a result of radioactive decay (DOE-ID 1997, Table 4-1). In addition, the wastewater also contained low concentrations of various other inorganic chemical constituents.

Known accidental discharges to the injection well during its operation included the following (WINCO 1992):

1. July 1953: The contents of a tank discharged to the wastewater flowing to the well. A postdischarge analysis showed that 51 mCi of radioactive contaminants were released in 923,640 L (244,000 gal) of water.

2. December 1958: About 29 Ci of radioactive contaminants, including 7 Ci of Sr-90, were released to the well.

3. September 1969: Two separate releases resulted in 19 Ci of fission products released to the well. Releases included Cs-137, Cs-134, Ce-144, and Sb-125 in 12.4 x 10‘ L (3.28 x 10^{6} gal) of wastewater.

4. December 1969: Two releases occurred in which the quantity of Sr-90 released was higher than expected. About 1 Ci, including 30% Sr-90, was released.

5. March 1981: Mercury was detected during routine monitoring of the INTEC Service Waste System. Mercury in the form of mercuric nitrate was released from CPP-601, through the INTEC Service Waste System, to the injection well. An estimated 0.207 mg/L of mercury was detected in service waste (Resource Conservation and Recovery Act [RCRA] toxicity characteristic leaching procedure [TCLP] limit for mercury is 0.2 mg/L).

A-5.3 RCRA Constituents

Four RCRA listed hazardous waste numbers have been determined to be applicable to waste in the PEW evaporator liquid waste system. The PEW evaporator overheads (condensate) are one of the liquid waste streams that were discharged to the injection well. Although any organic constituents that caused the PEW evaporator liquid waste stream to be “listed” are not likely to be present in the PEW evaporator condensate due to evaporation, application of the “derived from” rule [40 CFR 261.3(c)-(d)] causes the same hazardous waste numbers to carry over to the PEW evaporator overhead liquid waste. The four listed hazardous waste numbers and associated constituents that caused the listing are (INEEL 1999):

- F001 (carbon tetrachloride, trichloroethylene, and 1,1,1-trichloroethane)
- F002 (carbon tetrachloride, tetrachloroethylene, trichloroethylene, and 1,1,1-trichloroethane)

- F005 (benzene, carbon disulfide, pyridine, and toluene)
- U134 (hydrogen fluoride).

A-5.4 Suspended Solids

The service waste stream was derived from sources that included PEW evaporator condensate, water softener regeneration fluids (backflush), cooling waters, and basin waters. Process knowledge indicates that it is unlikely that these systems would contain suspended solids. Analytical data collected from the waste stream for permitting of the new INTEC percolation ponds indicate that essentially no suspended solids are present within the waters in recent years (total suspended solids [TSS] <5 mg/L). Plant processes such as the Liquid Effluent Treatment and Disposal (LET&D) system have been put in place to reduce the radionuclides present in the waste stream, but no such changes have been made to change the presence of suspended solids. Therefore, the more recent data for suspended solids are believed to be representative of the service waste historically discharged to the well (Bechtel 2001).

The wastewater was collected in a series of vaults before being pumped or gravity-fed to the injection well. A portion of any suspended solids would have accumulated in these vaults if they were present in the waste stream. There is no indication that sedimentation was ever a problem within the vaults. An attempt was made in 1993 to sample any sediments that may have accumulated within the CPP-709 vault. Insufficient sample material was present to fill a 500-ml sample container, and the limited material that was present in one corner of the vault appeared to have been small spalled concrete pieces (Bailey 2003).

A-6. ORIGIN OF WELL SEDIMENTS

Sediment material was present in the injection well casings and/or borehole from a depth of 475 ft to 598 ft at the time of abandonment in 1989. The specific interval and source of the sediment is described below and graphically represented in Figure A-5.

A-6.1 597 to 598 ft

One foot of cement was placed into the well in 1951 in order to seal the bottom of the well casing in place. This is standard well construction practice and is done in order to seal the casing in place and to prevent the annular fill gravel from entering the bottom portion of the well.

A-6.2 596.4 to 597 ft

The interval from 596.4 to 597 ft in depth is composed of materials that collapsed into the well during the well casing failure of the late 1960s. Material above this depth was removed during the 1970 well reconstruction.

A-6.3 588 to 596.4 ft

The interval from 588 to 596.4 ft in depth is composed of 9-7/8-in.-inside-diameter PVC pipe and fragments and “concrete aggregate” -sized gravel fill resulting from the failure of the PVC liner during construction on January 27,1971.

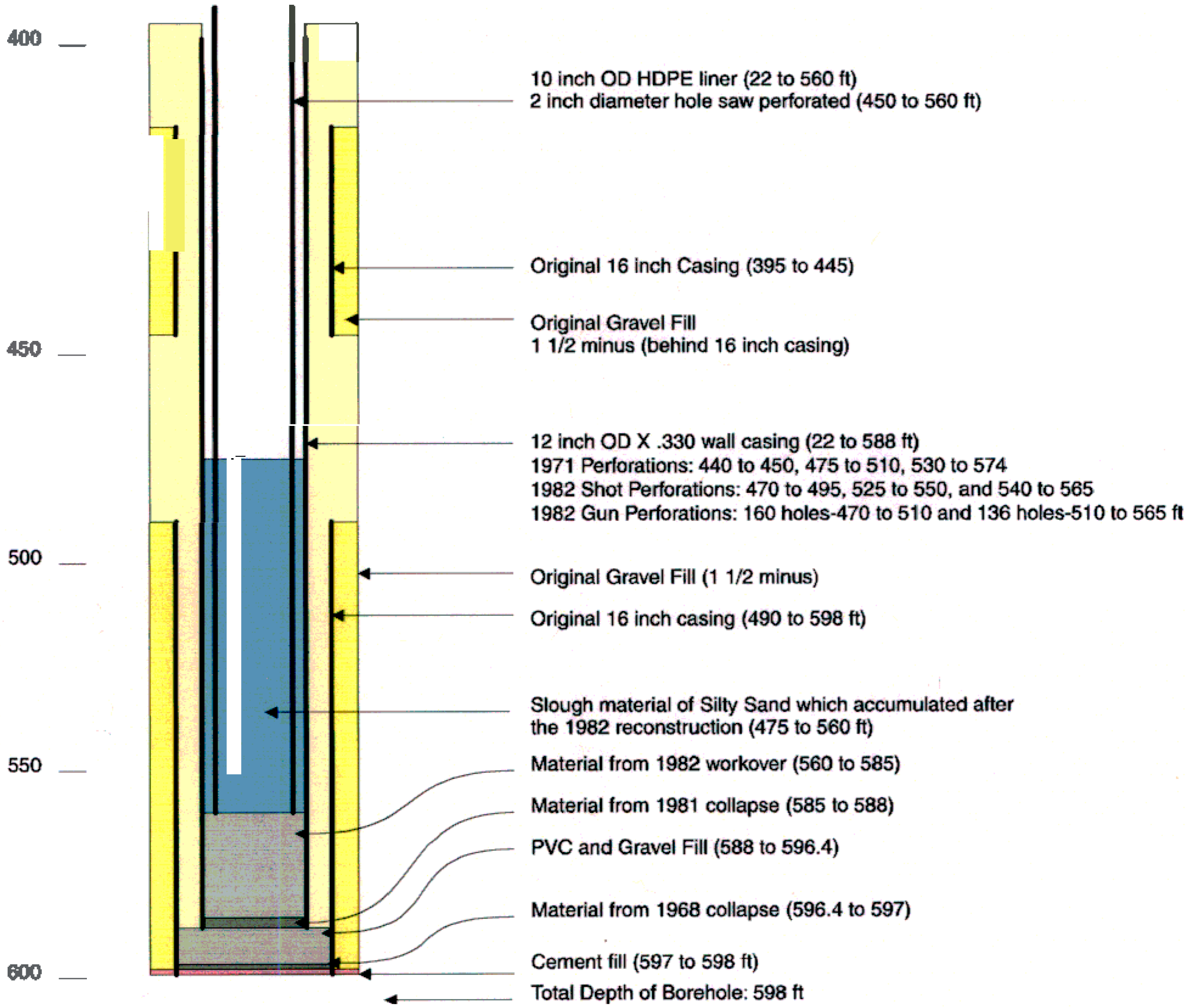


Figure A-5. Origin of the injection well sediments.

A-6.4 585 to 588 ft

The interval from 585 to 588 ft in depth is composed of materials that collapsed into the well during the well casing failure of 1981. Material above this depth was removed during the 1982 well reconstruction.

A-6.5 560 to 585 ft

The material from 560 to 585 ft began accumulating immediately after the 12-in. steel casing was gun-perforated on October 27, 1982. This zone was bailed many times and cleaned with a sand pump for several days. Large quantities of material were removed from the well and shipped to the RWMC. A decision was made to terminate the cleaning, due to the continued heaving material, and to place the HDPE liner to 560 ft in depth.

The material from 475 to 560 ft in depth accumulated in the HDPE liner between the reconstruction in late 1982 and the sealing of the well in 1989. When the HDPE liner was placed into the well, it was perforated with 2-in.-diameter holes cut with a hole saw. There is no evidence to suggest that the great difficulties associated with the heaving sands encountered during the 1982 reconstruction would be mitigated by a liner with 2-in.-diameter openings. Therefore, it is reasonable to assume that this material is similar in origin to the 28 ft of material that accumulated during 19 days of construction in 1982 and that the majority of this sediment entered the well rapidly following the 1982 work-over.

Review of several video logs filmed during the time period between the reconstruction of the well in 1982 and the abandonment of the well in 1989 reveals that the well sediments began accumulating shortly after the reconstruction of the well and continued after the routine use of the well was discontinued. The video log from 1986 clearly shows sediment “stains or streamers” entering the borehole from the 2-in.-diameter HDPE liner perforations. Table A-1 indicates the depth to which sediment had accumulated at various dates following the reconstruction, and the rate of sediment accumulation in the injection well is shown graphically in Figure A-6.

Table A-1. Sediment depth.

Date	Depth to Sediment
December, 1982	560 ft below land surface
March 2, 1984	516 ft below land surface
March 14, 1986	483 ft below land surface
July 13, 1988	481 ft below land surface
October 5, 1989	475 ft below land surface

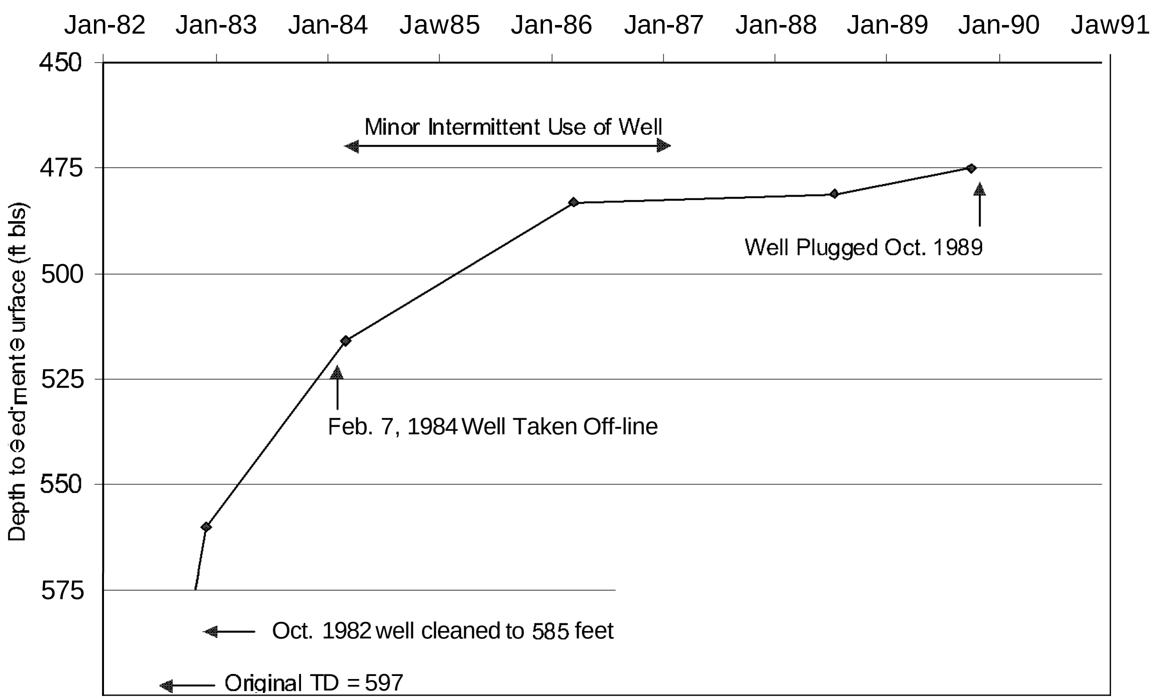


Figure A-6. Rate of sediment accumulation in injection well.

A-7. REFERENCES

40 CFR 261.3, 2003, "Definition of hazardous waste," *Code of Federal Regulations*, Office of the Federal Register, July 2003.

Amberson, C.B., 1971, ICPP Production Monthly Report No. 137, July 27 through August 26, 1971, Allied Chemical Corporation, Amb-164-71.

Bailey, A. L., May 2003, Sampling of the CPP-709 Vault, Letter to INEEL file, May 19,2003, Located in WAG 3, 3-14 Injection Well, Project Files.

Barraclough, J. T., 1970, Letter to Dr. C.A. Pelletier, Chief Environmental Branch, AEC, NRTS, Information about the ICPP Disposal Well, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Barraclough, J. T., 1981, ICPP Disposal Well - Current Conditions and Proposed Future Modifications, Letter to Warren **S.** Nechodom, ENICO, CPP-652, September 21, 1981, Located in: CPP-03 Folder, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Barraclough, J. T., 1982, ICPP Disposal Well - Deterioration of the 10-inch PVC Liner, Letter to Don Alexander, ENICO, CPP, July 15, 1982, Located in: CPP-03 Folder, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Bechtel, 2001, History of INTEC Service Wastewater Characterization Activities, Engineering Design File EDF-ER-249 Rev. A, May 29,2001.

Bechtel, 2003, Results of 2001 Groundwater Sampling in Support of Conditional No Longer Contained-In Determination for the Snake River Plain Aquifer in the Vicinity of the Idaho Nuclear Technology and Engineering Center, INEEL/EXT-02-00557, U.**S.** Department of Energy, Idaho Operations Office, April 2002.

Caudill, H. L., 1982, Environmental Evaluation for ICPP Disposal Well, Environmental Records File Number 006642, Environmental Records Center, Willow Creek Building, Idaho Falls, Idaho.

DOE-ID, November 1997, Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL, DOE/ID-10572, U.S. Department of Energy, Idaho Operations Office.

EG&G, 1989, ICPP Injection Well Abandonment Well MAH-FE-PL-304, Drawing Number 172091, U.S. Department of Energy, Idaho Operations Office, April 1989.

EINCO, 1972, Injection Well Installation of 10" PVC Liner Drawing, Exxon Idaho Nuclear Corporation, Drawing Number 400220, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

EINCO, 1982, Technical Specifications, Service Waste Injection Well flushing Lines and Settling Pond, S-2239, Environmental Records File Number 012415, Environmental Records Center, Willow Creek Building.

Gibeault, G. L. and B. L. Phillips, 1982, Daily Logs for the 1982 Reconstruction of the Injection Well, Exxon Idaho Nuclear Corporation Environmental Records File Number 012413, Environmental Records Center, Willow Creek Building.

Gibeault, G. L., 1983, HDPE Liner Perforation Diagram, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Gildersleeve, R. P. M., 1970, CPP Iniection Well- Report of the Exploration Subcontract, Letter to C. L. Murray, CPP-602, June 23, 1970, Located in: CPP-03 Folder, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL

Harmel, D. M., 1989, Summary Report for the August 31, 1989 Sampling of Injection Well CPP-23, Letter to A. R. Eberle, Manager Waste Processing Projects, Westinghouse Idaho Nuclear Company, Inc., September 26, 1989.

INEEL, 1999, “A Regulatory Analysis and Reassessment of U.S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System” INEEL/EXT-98-01213 (February, 1999).

INEEL, 1997, Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL – Part A, RI/BRA Report (Final), DOE/ID-10534, Nov. 1997.

Johnson, G. D., 1982, ICPP Disposal Well Caliper, Flow, and Video Log Summary, July 13, 1972, Located in: CPP-03 Folder, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Lane, Ron, 1990, Review of Analytical Results from CPP-23 Injection Well Abandonment / INEL, Letter to INEL File/CPP-23, State of Idaho, Division of Environmental Quality, Boise, Idaho, February 21,1990.

Leenheer, Jerry A., and J.C. Bagby, 1982, IDO-22061, Organic Solutes in Groundwater at the Idaho National Engineering Laboratorv, USGS WRIR 82-15.

McCabe, W. E., 1982, Daily Shift Report for the CPP#3 1982 Work-over, Environmental Records File Number 012412 (Also found as File Number 006634), Environmental Records Center, Willow Creek Building.

Micum, M. R., 1971a, Daily Logs for the Injection Well Reconstruction, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Micum, M. R., 1971b, Pay Sheets, Letters to File, and Notes for the Injection Well Reconstruction, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Micum, M. R., 1971c, Daily Logs for the Installation of the PVC Liner, Environmental Records File Number 006637, Environmental Records Center, Willow Creek Building.

MSE Inc., 1995, Waste Area Group 3 Remedial Investigation/Feasibility Study Final Work Plan, prepared for the U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho.

Nace, R. L., Morris Deutsch, and P. T. Voegeli, 1956, Geography, Geology, and Water Resources of the National Reactor Testing Station, Idaho, IDO-22033, U.S. Geological Survey, Boise, ID.

Robertson, J. B., Robert Schoen, and J. T. Barraclough, 1974, The Influence of Liquid Waste Disposal on the Geochemistrv of Water at the National Reactor Testing Station, Idaho, USGS Open File Report IDO-22053, issued by the U.S. Atomic Energy Commission, Idaho Falls, Idaho, February, 1974.

Sisco, H.G., 1951, Well Schedule for CPP #3, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Stoops, Tom, 2000, Listed Waste in Groundwater at INTEC Issue Briefing, presented to State of Idaho Department of Environmental Quality, Jan. 6,2000.

Strausser, R.J., 1950, Well logs for Well Construction, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

Strausser, R.J., 1951, Well logs for Well Construction, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

United States Geological Survey, 1951?, Various As-Built Diagrams for ICPP-03, USGS Well Resource Files, Russell Building, Central Facilities Area, INEEL.

WINCO, 1987, Closure/Post Closure Plan for the CPP-37, ICPP Gravel Pits #1 and #2, Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, ID, November 6, 1987.

WINCO, 1990, Closure Plan for LDU CPP-23 Injection Well (MAH-FE-PL-304), Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, ID, March, 1990.

WINCO, 1991, ICPP Injection Well: Mercury Release, Westinghouse Idaho Nuclear Company, Inc. Environmental Records File Number 003818, Environmental Records Center, Willow Creek Building.

Appendix B

Service Waste Composition Graphs

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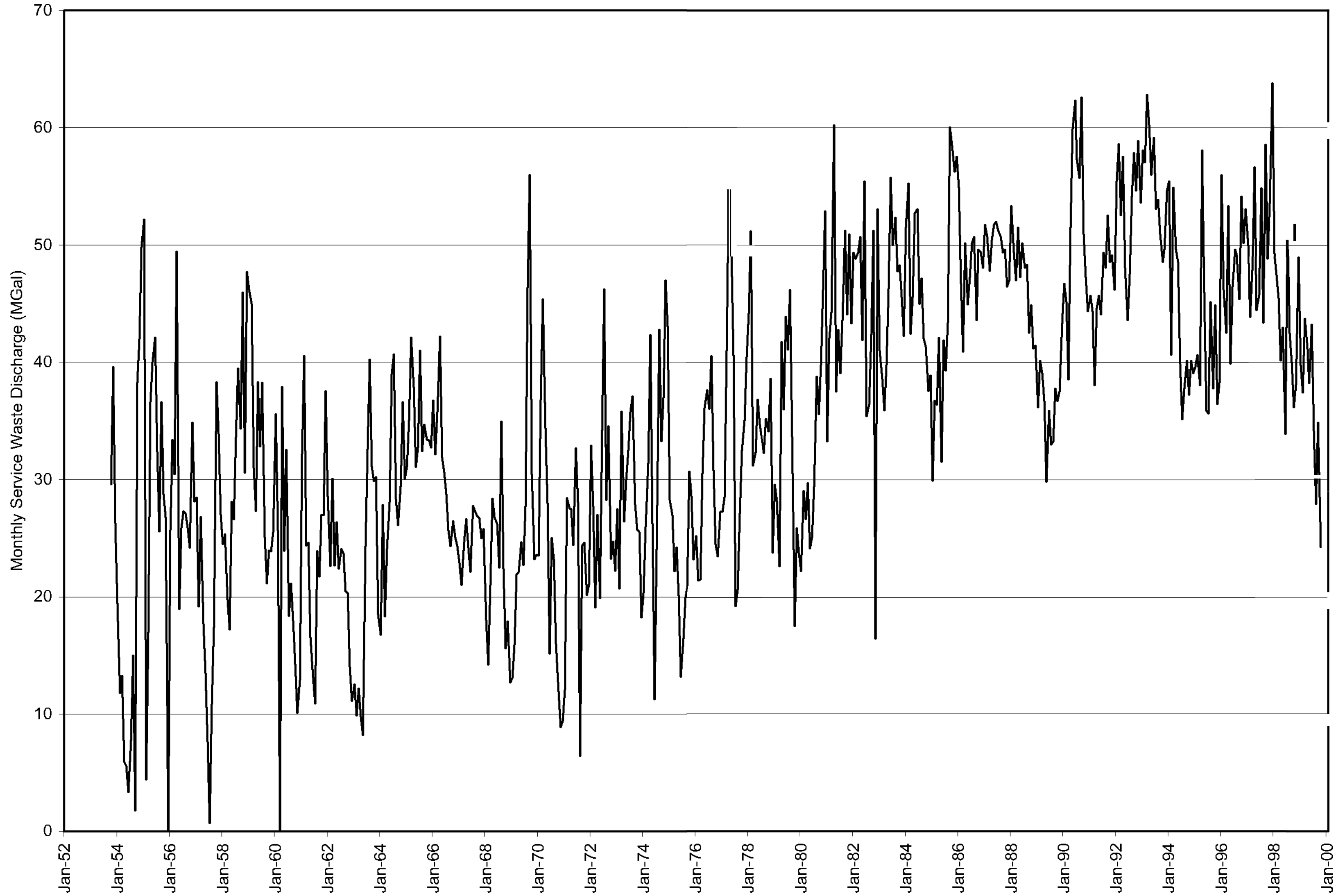
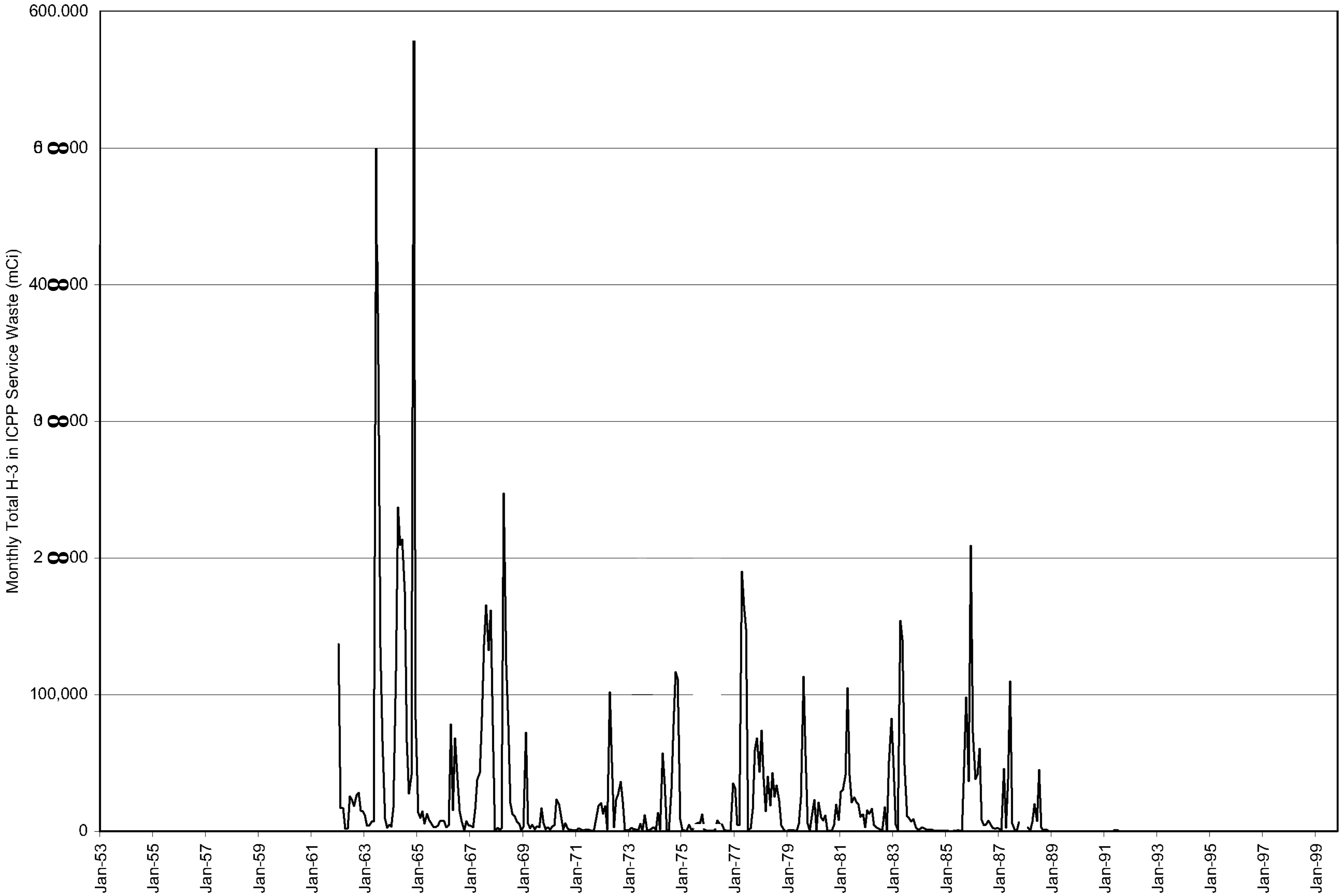
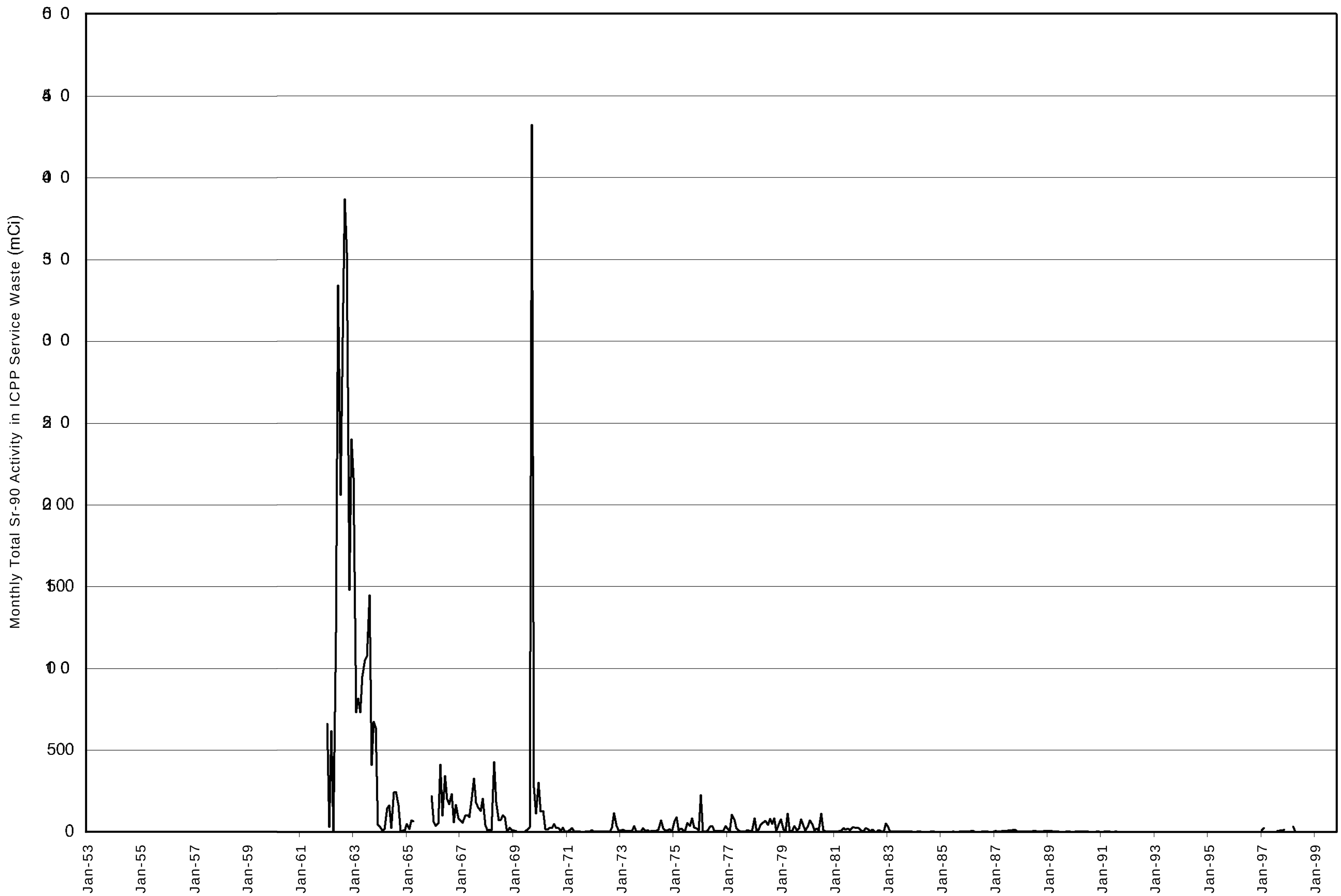
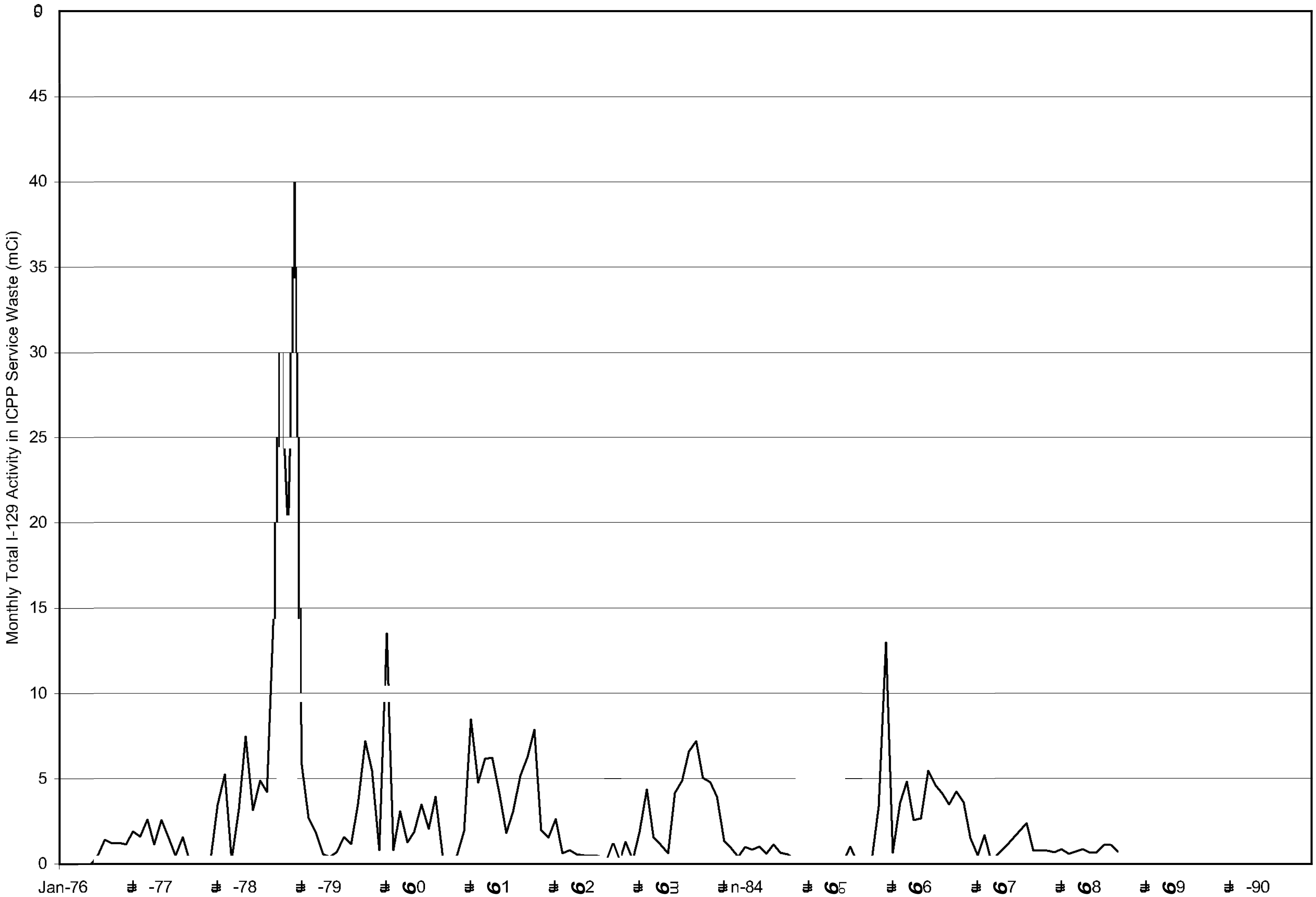
Service Waste Composition Graphs




600,000
100,000
0
Monthly Total H-3 in ICPP Service Waste (mCi)
Jan-53
Jan-55
Jan-57
Jan-59
Jan-61
Jan-63
Jan-65
Jan-67
Jan-69
Jan-71
Jan-73
Jan-75
Jan-77
Jan-79
Jan-81
Jan-83
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99


Monthly Total Sr-90 Activity in ICPP Service Waste (mCi)
500
0
Jan-53
Jan-55
Jan-57
Jan-59
Jan-61
Jan-63
Jan-65
Jan-67
Jan-69
Jan-71
Jan-73
Jan-75
Jan-77
Jan-79
Jan-81
Jan-83
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99


Monthly Total I-129 Activity in ICPP Service Waste (mCi)
0
5
10
15
20
25
30
35
40
45
Jan-76
-77
-78
-79
n-84
-90

Appendix C

Iodine-I29 Source Term Evaluation for Operable Unit 3-13, Group 5, Snake River Plain Aquifer

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ABSTRACT

The Idaho Nuclear Technology and Engineering Center located at the Idaho National Engineering and Environmental Laboratory discharged wastewater containing iodine-129 to a deep injection well from 1952 to 1986. Modeling of iodine-129 transport within the Snake River Plain Aquifer has been problematic due to uncertainty regarding the total amount of 1-129 injected to the aquifer, particularly because analytical data for 1-129 in the service waste are available only following 1976.

Plant processes and procedures were examined along with the existing 1-129 data to attempt to quantify the inventory of 1-129 that was injected into the aquifer before the analysis of the waste stream began in 1976. A source term of 0.856 Ci of 1-129 was computed for the period that the injection well was in service. This value is significantly lower than that previously assumed during numerical modeling and risk assessment.

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CONTENTS

FIGURES

TABLES

ACRONYMS

APS	Atmospheric Protection System
CPP	Chemical Processing Plant (designation for buildings and areas at INTEC)
DOE	Department of Energy
HLLW	high-level liquid waste
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
PEW	process equipment waste
WCF	Waste Calcining Facility

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I-129 Source Term Evaluation for Former INTEC Injection Well

C-1 INTRODUCTION

The Idaho Nuclear Technology and Engineering Center (INTEC) located at the Idaho National Engineering and Environmental Laboratory (INEEL) discharged wastewater to a deep injection well from 1952 to 1986. Contaminants disposed in the former injection well were primarily tritium (H-3) and strontium-90 (Sr-90), although elevated levels of iodine-129 (1-129) were also present in the waste stream. Groundwater modeling has indicated that 1-129 may pose a risk to groundwater users at a future date (DOE-ID 1997). However, this modeling is based upon incomplete information regarding the amount of 1-129 disposed of through the injection well. Analytical data for 1-129 in service waste disposed of to the injection well are available only following 1976. In addition, an erroneous assumption had been made that the 1-129 discharge rate to the injection well had been constant.

Plant processes and procedures were examined along with the existing 1-129 data to attempt to quantify the inventory of 1-129 that was injected into the aquifer before 1-129 analysis of the waste stream began in 1976. This analysis yielded a revised 1-129 source strength that is significantly lower than that estimated previously during the RI/BRA (DOE-ID 1997).

C-1.1 Site History

The INEEL is a U.S. Government-owned facility managed by the Department of Energy (DOE). INTEC has been in operation since 1952 with an original mission of research, storage of spent nuclear fuel, and reprocessing of spent nuclear fuel from defense-related projects for the recovery of enriched uranium. The DOE phased out the reprocessing operations in 1992 and redirected the plant's mission to (1) receive and temporarily store spent nuclear fuel and other radioactive wastes for hture disposition, (2) manage current and past wastes, and (3) perform remedial actions.

INTEC produces approximately 3.8 million (M) liters (1 M gal) of wastewater per day. This wastewater consists primarily of demineralizer backwash, cooling water, and steam condensate. Prior to 1984, this wastewater was disposed of to an onsite deep injection well. Routine injection to the well was discontinued in 1984 when two infiltration/percolation ponds were constructed. Only minor use of the injection well occurred in 1985-1986. The injection well was permanently plugged by pressure-grouting in 1989.

Analytical data for the amount and concentrations of 1-129 disposed of within the wastewater stream are available from approximately 1976 to the end of injection in 1986. 1-129 activities in the service waste were not measured from 1952 to 1976. Previous attempts to model the 1-129 plume within the aquifer have used the average monthly 1-129 value for the period from 1976 to 1984 and have applied this average value to the early time period. However, due to significant changes in plant facilities and processes over this time period, this previous estimate may not be accurate.

C-1.2 Total I-129 at INTEC

1-129 is a fission product produced during the fission of uranium in nuclear reactors. A larger quantity of 1-129 is produced in the reactor the longer fuel is allowed to fission. Attempts have been made to compute the total amount of 1-129 in the spent fuel received at the INTEC facility by computing the number of fissions that had occurred in each batch of fuel processed at the facility (Cordes 1978). This computation produces an upper limit value of 5.0 Ci of 1-129 that could have been released or stored at the facility from 1953 through 1977.

The 1-129 present in the fuel enters the many plant processes and may be released to the environment through several different pathways. A portion of the 1-129 may also be stored in the liquid (tank farm) and solid (calcine) wastes. To determine the likely 1-129 release pathways at the INTEC facility, an evaluation of spent fuel reprocessing campaigns and waste calcination campaigns has been performed. An understanding of the specific chemical and physical characteristics of 1-129, as well as the plant processes, has been used to determine the fate of the 1-129 present in the fuel.

C-2 INTEC PROCESSES

The spent nuclear fuel arriving at the INTEC facility was processed to remove any remaining uranium for recycling. The liquid waste products produced from the fuel dissolution and uranium extraction processes were sent to the INTEC tank farm. Most of the liquid waste was later calcined, and the granular waste product (calcine) is currently stored in stainless steel bin sets contained in reinforced concrete vaults.

Several steps are involved from the receipt and storage of the spent fuel elements to the solidification of the waste byproducts. A review of the major steps of reprocessing is required to understand the potential pathways for release of 1-129 to the environment. The following discussion is a brief description of the spent fuel reprocessing steps conducted in the past at the INTEC facility. (McManus et al. 1982).

C-2.1 Fuel Storage

Spent fuel elements were stored in the basin waters located in Building CPP-603 near the south end of the INTEC facility during the time the injection well was used. 1-129 could enter the basin waters if fuel elements leaked or ruptured. Water was removed from the storage basins, and fresh makeup water was added in sufficient quantities to reduce concentration levels if basin water chemistry exceeded specified upper limits for a variety of analytes. Before 1964, excess basin water was sent to a shallow infiltration pit located just to the west of Building CPP-603. After 1964, waste basin water was sent to the process equipment waste (PEW) evaporator. The evaporator condensate was disposed of, along with the service waste stream, to the former injection well.

C-2.2 Fuel Dissolution

The fuel elements were dissolved in acid prior to uranium extraction. During fuel dissolution, approximately *5%* of the 1-129 present in the spent fuel was lost to the atmosphere via the off-gas system (McManus et al. 1982). The remaining 95% of the 1-129 entered the uranium extraction process in Building CPP-601 in the dissolver product (McManus et al. 1982).

C-2.3 Uranium Extraction

The first-cycle extraction process removed the uranium from the dissolved fuel solution. The bulk of the 1-129, as well as other fission products in the fuel solution, remained in the residual solution referred to as first-cycle product stream. The first-cycle product contains approximately 85% of the 1-129 present in the spent fuel elements and was sent to the high-level liquid waste (HLLW) tank farm for storage. The first-cycle product solution was further processed through a series of steps to isolate the uranium.

Additional purification of the uranium was performed in second- and third-cycle separations. Evaporators and steam stripping were used in the first, second, and third cycles for concentration of the uranium solutions and cleaning of the extraction solvents. The condensate from these evaporator and steam stripping operations was sent to the waste collection system.

An “upset” of the first-cycle extraction system occurred during August-October 1978, leading to a criticality event on October 7, 1978 (DOE-ID 1978). During this column upset, a higher-than-normal amount of 1-129 appears to have passed into the second- and third-cycle extraction columns. This additional 1-129 was released from the second and third cycles to the PEW evaporator and then to the injection well. This event is believed to be responsible for the anomalously high 1-129 activities discharged to the injection well during the late summer and early fall of 1978.

C-2.4 Liquid Waste Storage

Liquid waste from uranium reprocessing was sent to the tank farm where it was stored in 300,000-gal underground storage tanks. The first-cycle extraction wastes were typically stored separate from second- and third-cycle wastes, which were often stored together. Decontamination fluids and evaporator bottoms were often combined with the second- and third-cycle products.

C-2.5 High-Level Waste Evaporation

The high-level liquid waste (HLLW) evaporator was used to concentrate the more dilute wastes from the tank farm before calcination. Evaporation was often conducted on the second- and third-cycle wastes and on the decontamination solutions. Occasionally, evaporation was conducted on the first-cycle product solutions. Inspection of the tank farm records from monthly reports indicates that, during the period for which 1-129 analytical data are available (1976-1984), there were two episodes of HLLW evaporator concentration of first-cycle wastes. Heating and evaporation of the first-cycle wastes cause more of the 1-129 to volatilize and enter the PEW stream and, hence, be sent to the service waste and into the injection well.

C-2.6 Calcination

Calcining of high-level liquid waste at INTEC began in 1963 with the startup of operations in the Waste Calcining Facility (WCF). All first-cycle wastes were stored in underground tanks in the HLLW tank farm prior to the startup of this facility in 1963. The calciner heats the waste solution in a fluidized bed to form solid, granular, calcine particles, which are transferred to storage in stainless steel tanks (bins) encased in concrete vaults (bin sets). Much of the 1-129 present in the liquid waste is volatilized into the off-gas. Some of the 1-129 may have been recaptured by the atmospheric protection system (APS) and returned to the PEW evaporator. Additional 1-129 is also directed to the PEW during the dissolution of the calciner bed at the end of a run and during the associated decontamination process.

C-2.7 Off-Gas System

The APS system was installed into the off-gas waste stream in 1976. The APS condenser operated intermittently until approximately 1980 and may have been responsible for removing some 1-129 from the off-gas and directing it to the PEW and, hence, down the injection well (McManus et al. 1982).

C-2.8 Process Equipment Waste Evaporator

The PEW evaporator was used to reduce the volume of dilute wastes through evaporation. The concentrated evaporator bottoms were transferred to the tank farm and ultimately to the WCF calciner. The evaporated portion was condensed and directed into the service waste system. 1-129 within the waste stream volatilizes into the vapor phase and is then condensed along with the water and sent to the injection well with the service waste. Nearly all 1-129 present in the service waste is processed through the PEW evaporator. The PEW evaporator is only the final step in this waste stream, as several other systems contribute I-129-contaminated waste to the PEW.

C-3 EVALUATION OF 1-129 DISCHARGES TO SERVICE WASTE

An evaluation of 1-129 transport at INTEC by McManus et al. (1982) demonstrates that most of the 1-129 released to the environment comes from a limited number of sources. The process model and analytical data were used to determine the likely distribution of 1-129 within the INTEC process based on the individual systems operating during any given time. The time periods that various systems were operating were plotted against the monthly discharge values of 1-129 to the service waste (Figure C-1). The graphical representation of 1-129 data indicates that the highest periods of 1-129 discharge correlate well with the times that the calciner or the high-level waste evaporator were operational. Therefore, 1-129 activities in the service waste and airborne discharges were computed for time periods that the calciner was either operational or nonoperational.

C-3.1 Calciner Facility in the Nonoperational Mode

Analytical data for 1-129 were compiled for the time periods that the WCF was not operating, and an average activity in service waste was computed. For the period for which analytical data are available (between 1976 and 1986), the average monthly activity of 1-129 discharged to service waste was 0.88 mCi/month. This quantity likely represents the total amount of 1-129 present in the evaporator, and strip and wash processes involved in fuel reprocessing, as well as 1-129 derived from evaporation of stored wastes through the PEW evaporator system.

Figure C-2 shows a schematic diagram of the 1-129 pathways present when the calciner is not operational, as presented by McManus et al. (1982). A comparison of airborne versus service waste discharge of 1-129 is presented in Table C-1. The ratio of observed 1-129 activities in the airborne and service waste streams at INTEC closely resembles that predicted by the McManus et al. (1982) model.

C-3.2 Calciner and HLLW Evaporator Operating

Analytical data were compiled for the time periods that the WCF and/or the high-level liquid waste evaporator was operating, and an average value for 1-129 in-service waste was computed. For the period of analytical data between 1976 and 1986, this average monthly value computed as 4.21 mCi/month of 1-129 discharged to service waste. The possible waste streams that transport 1-129 during calcination and HLLW evaporator operation are shown in Figure C-3. A comparison of airborne versus service waste discharge of 1-129 is presented in Table C-2. The ratio of airborne versus service waste 1-129 from the analysis of the waste stream at INTEC falls between the end member values postulated by McManus et al. (1982) for time periods when (1) all of the liquid waste being processed in the calciner was being directed through the HLLW evaporator and (2) the HLLW evaporator was not operating.

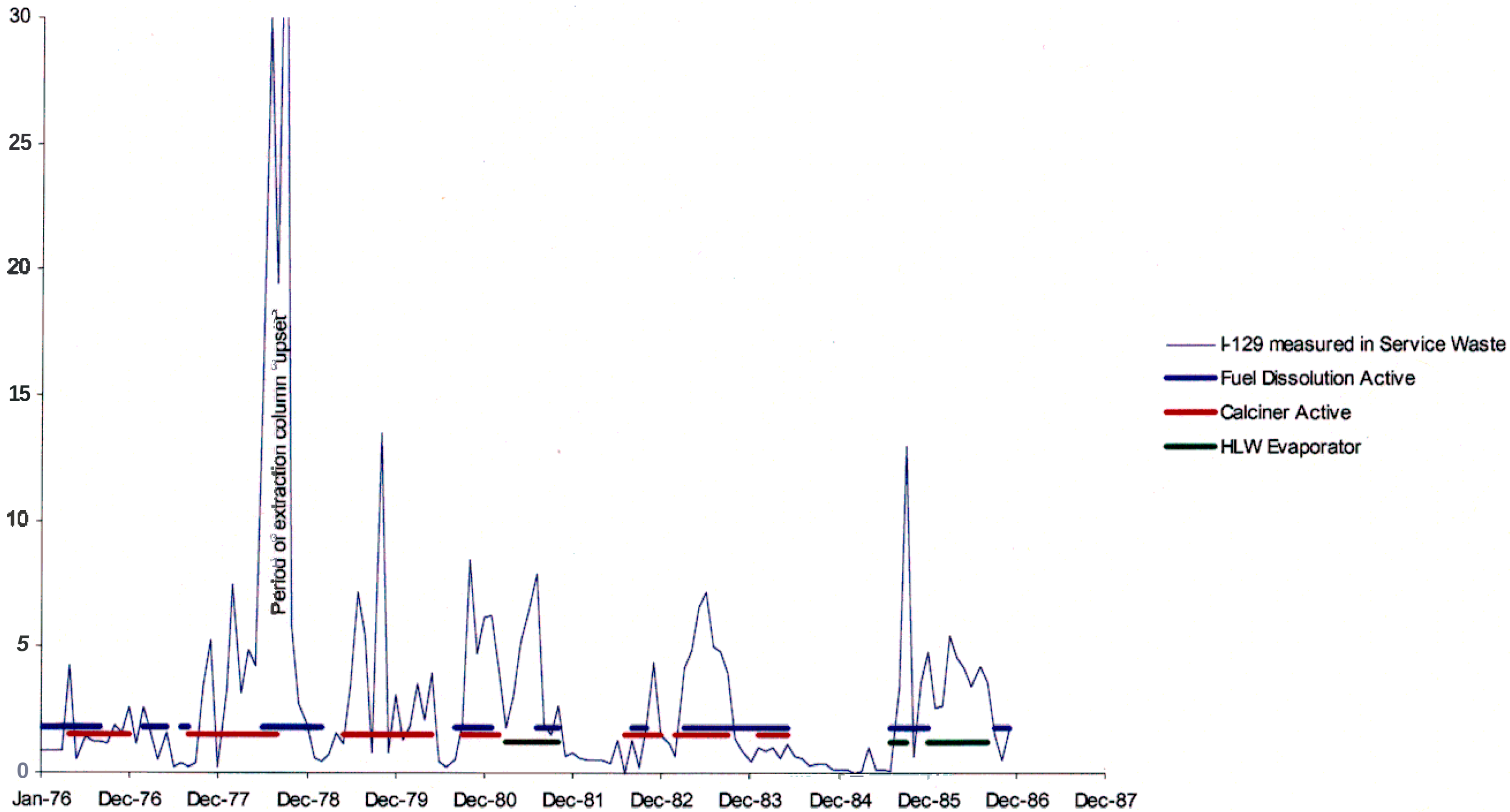

Figure C-1. Monthly discharge of I-129 to the service waste (mCi/month) plotted against INTEC operational systems.

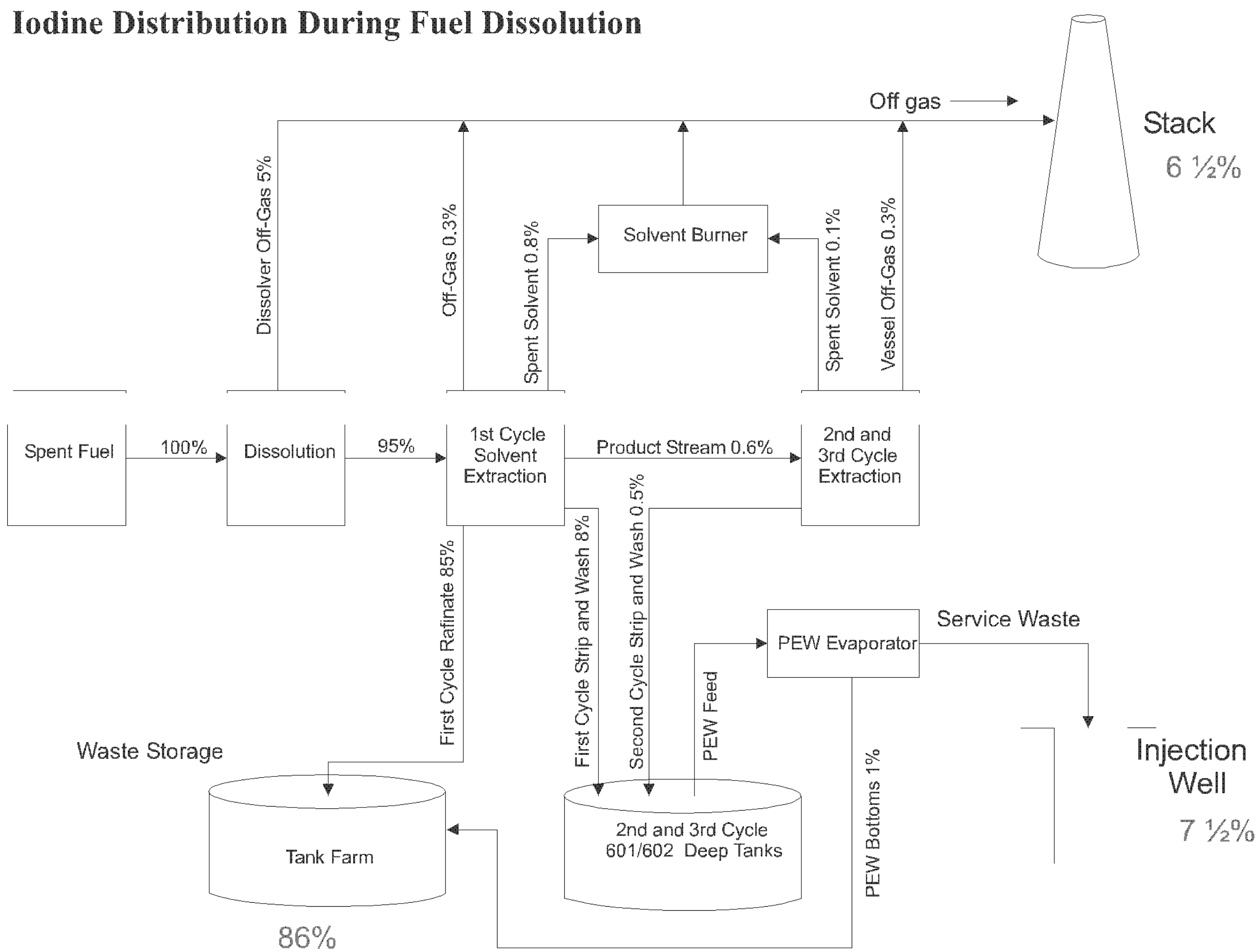

Figure C-2. I-129 pathways during fuel dissolution.

Table C-1. Ratios of airborne versus service waste 1-129 discharges during calciner shutdown.

Ratio of Waste Stream 1-129 Activities	Measured Ratio	Predicted Ratio (from McManus et al. 1982)
Service waste : airborne	1 : 1.15	1 : 1.06

Table C-2. Ratios of airborne versus service waste 1-129 discharges during waste calciner operation.

Ratio of Waste Stream 1-129 Concentrations	Measured Values	Predicted Without Evaporation (from McManus et al. 1982)	Predicted With Evaporation (from McManus et al. 1982)
Service waste : airborne	1 : 4.55	1 : 0.55	1 : 9.7

Additionally, McManus et al. (1982) performed laboratory experiments that demonstrated that the rate of evaporation was critical to the percentage of 1-129 that volatilized into the service waste stream. The observed ratios of airborne versus service waste 1-129 were used to develop the numerical percentages applied to each waste stream shown in Figure C-3. It was assumed that normal plant processes would be contributing 1-129 at the rates computed in the previous section (approximately equal values to the service waste and airborne releases). The actual values were then estimated assuming that approximately one-fifth of the I-129 was processed through the HLLW evaporator prior to calcination.

It should be noted that the 1-129 source term determination is based only on the final airborne and service waste 1-129 activities. The apportionment of 1-129 among the various waste streams within the facility does not impact the total source term, but this exercise was performed to better understand which processes contribute the most 1-129 to the service waste.

C-4 1-129 SOURCE TERM TO SERVICE WASTE

Three sets of values were used to compute the total 1-129 source term that was directed to the injection well in the service waste:

1. The actual measured discharge amounts were used for the time periods for which analytical data are available in the Radioactive Waste Management Information System (RWMIS) database. These data are available from May 1976 until use of the injection well was discontinued in 1986.

2. For the earlier time period when analytical data are not available, two separate computed values were used:

   a. The average calciner nonoperating value of 0.88 mCi/month of 1-129 was used when the calciner was not operating and before it was constructed (pre-1963).

   b. The average operating value of 4.21 mCi/month was used when the calciner and/or the HLLW evaporator was operating.

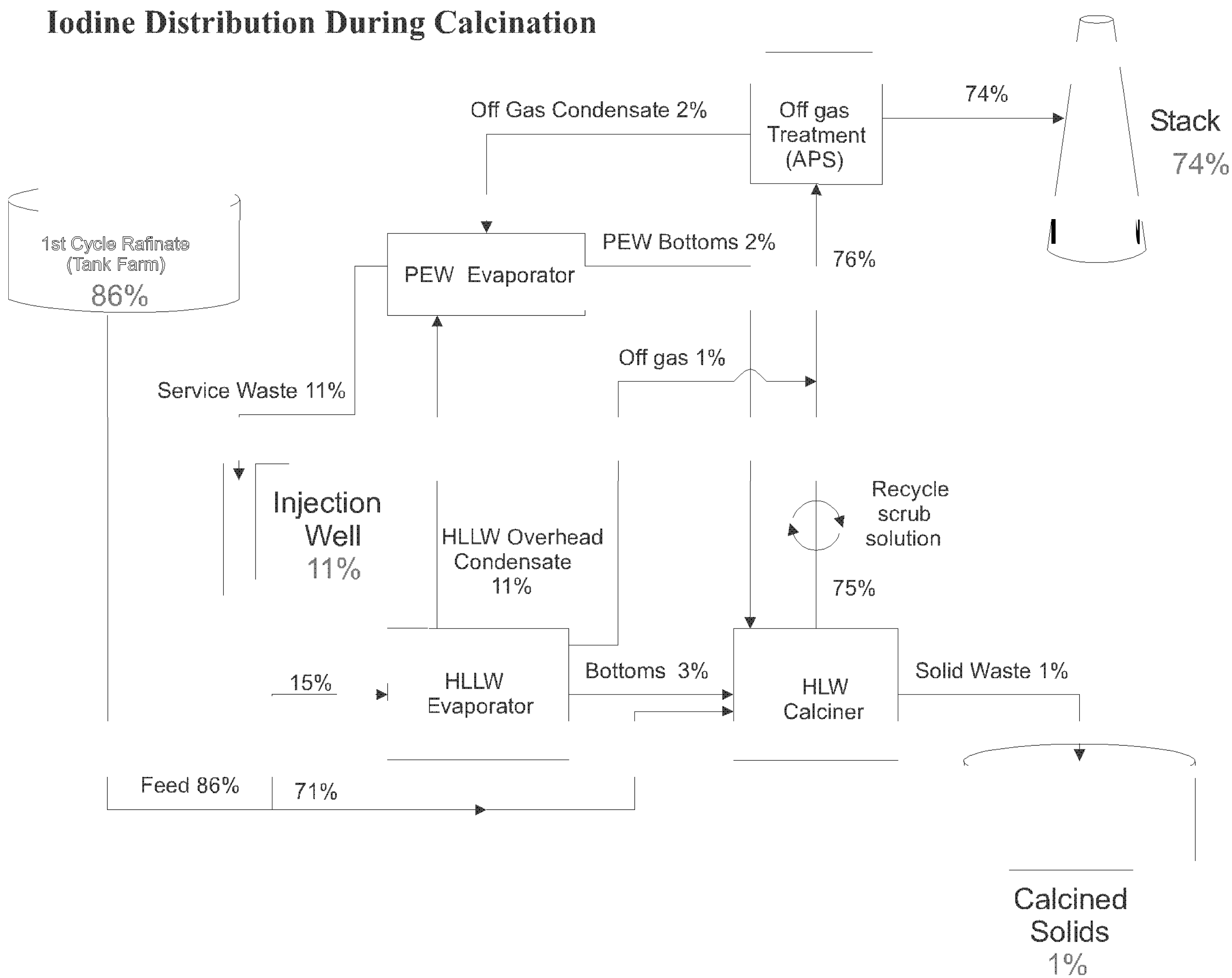

Figure C-3. I-129 pathways during calciner and high-level liquid waste evaporator operations.

A summation of these monthly values indicates that the total 1-129 source term to the injection well over its lifetime was 0.856 Ci.

The anomalously high 1-129 activities observed during the column "upset" during August through October 1978 were included in the calculations of monthly average 1-129 discharges, as it is believed that a similar event may have occurred in 1957.

C-5 REFERENCES

Cordes, Ormand L., Allied Chemical, to Jack T. Barraclough, USGS, April 18, 1978, "I-129 in Liquid and Airborne Effluents," Cord-53-78.

DOE-ID, 1997, *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL-Part A, RI/BRA Report (Final),* DOEAD-10534, Rev. *0,* U.S. Department of Energy Idaho Operations Office, November 1997.

DOE-ID, 1978, Recovery of ICPP from Criticality Event of October 17, 1978, prepared by Allied Chemical Idaho Chemical Programs, ACI-362, Nov. 1978.

McManus, G.J., F.A. Duce, S.J. Fernandez, and L.P. Murphy, 1982, A model of iodine-129 process distributions in a nuclear fuel reprocessing plant, Exxon Nuclear Idaho Company, Inc., ENICO-1108, 41p.

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Appendix D

Groundwater Quality and Trends

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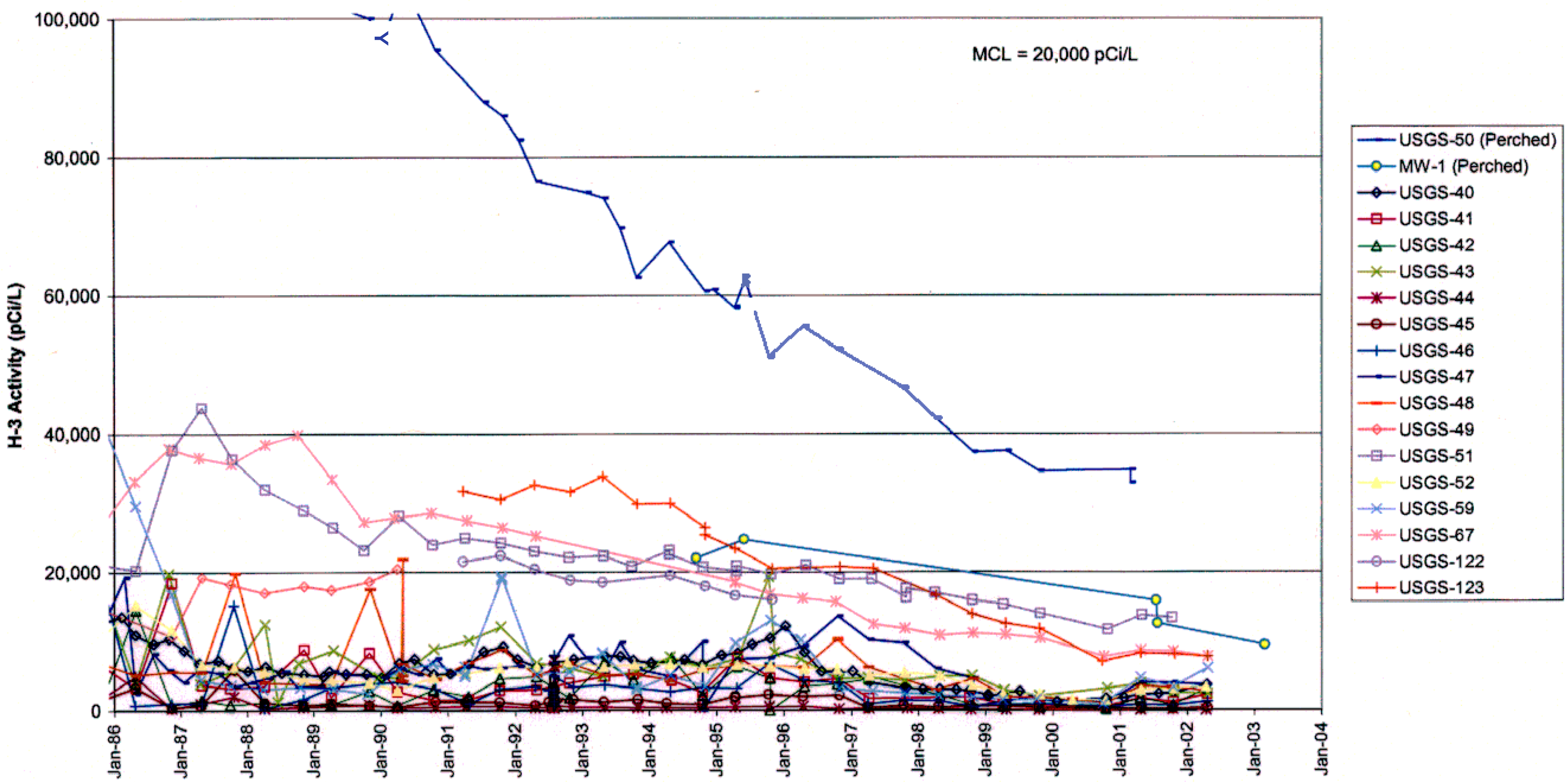
Groundwater Quality and Trends

Summary of VOC Detections In Groundwater for Selected Wells Downgradient of INTEC

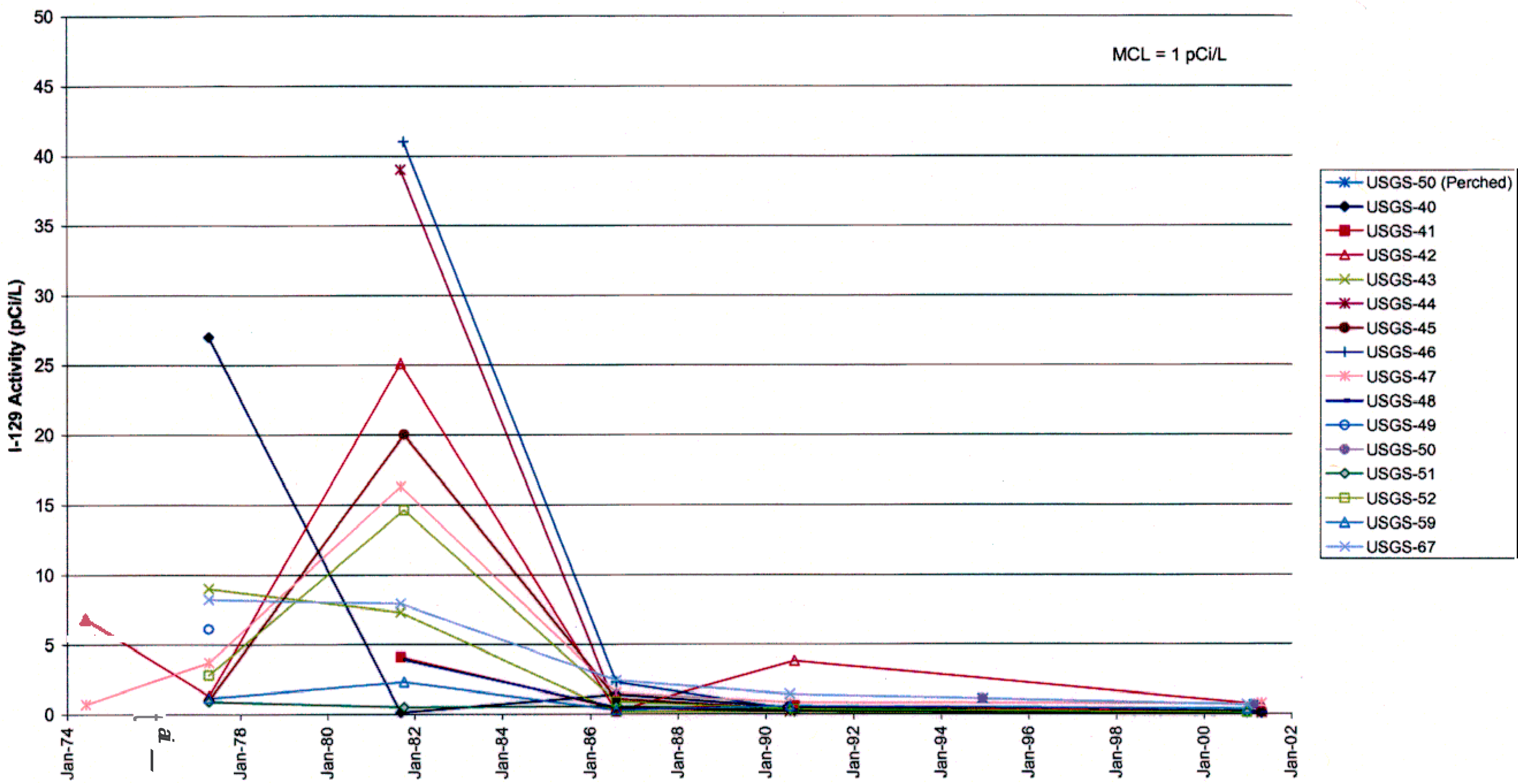
WELL–NAME	Samp Date	Depth (ft)	Chloroform	Carbon tetrachloride	1,1-DCA	1,1-DCE	1,1,1-TCA	TCE	PCE	CFC-12	Benzene	Toluene	Data Source	Other
EPA MCL (µg/L)			100'	5	NS	7	200	5	5	NS	5	1000		
ICPP Service Waste	08/01/80		<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	IDO-22061	
SRPA Wells														
USGS-040	08/18/80	456-678	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	IDO-22061	
	10/13/87		<0.2	<0.2	<0.2	<0.2	03	<0.2	c0.2	<0.2	<0.2	<0.2	DOHID-22074	
	10/18/89		<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	Closure Plan for LDU CPP-23	
USGS-041	10/16/90	428-674	<0.2	<0.2	co.2	co.2	<0.2	<0.2	<0.2	<0.2	<0.2	c0.2	DOHID-22104	
USGS-042	10/16/90	452-678	<0.2	<0.2	co.2	<0.2	<0.2	<0.2	<0.2	co.2	<0.2	<0.2	DOHID-22104	
USGS-043	08/18/80	450-675	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	IDO-22061	
	10/05/87		<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	DOHID-22074	
	06/21/88		<0.2	<0.2	<0.2	co.2	co.2	<0.2	<0.2	<0.2	<0.2	<0.2	DOHID-22089	
USGS-044	10/18/89	461-650	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	Closure Plan for LDU CPP-23	
	10/26/90		<0.2	c0.2	<0.2	<0.2	0.3	<0.2	40.2	<0.2	<0.2	<0.2	DOHID-22104	
	07/01/92		<0.2	co.2	<0.2	<0.2	<0.2	<0.2	c0.2	<0.2	<0.2	<0.2	DOHID-22146	
	07/20/92	495-515	<0.2	<0.2	<0.2	<0.2	03	<0.2	<0.2	<0.2	co.2	0.2	DOHID-22146	
	07/24/92	535-555	co.2	co.2	<0.2	<0.2	0.2	r0.2	<0.2	<0.2	<0.2	1.4	DOE/ID-22146	
	07/28/92	557-577	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.6	DOHID-22146	
	07/30/92	580-TD	<0.2	<0.2	co.2	<0.2	0.2	<0.2	<0.2	<0.2	c0.2	1.1	DOE/ID-22146	
	08/03/92	580-600	<0.2	co.2	<0.2	<0.2	<0.2	<0.2	c0.2	<0.2	<0.2	<0.2	DOE/ID-22146	
	08/14/92	467-482	<0.2	c0.2	<0.2	<0.2	0.5	<0.2	<0.2	co.2	<0.2	<0.2	DOE/ID-22146	
	08/18/92	519-534	<0.2	c0.2	c0.2	<0.2	0.3	<0.2	<0.2	co.2	<0.2	0.8	DOE/ID-22146	
	04/24/01		<1	<1.4	<1.3	41.5	<0.88	<1.3	<1.6	NR	4.1	<1.2	INEEUEXT-02-00557	MeCl=15J
USGS-044 DUP	04/24/01		<1	<1.4	<1.3	<1.5	<0.88	<1.3	<1.6	NR	<1.1	<1.2	INEEUEXT-02-00557	MeCl=19J
USGS-044	10/09/01		<0.24	<0.65	<0.38	<1.3	<0.44	<0.31	<0.36	NR	<0.37	<0.54	INEEUEXT-02-00557	
USGS-044 DUP	10/09/01		<0.24	<0.65	<0.38	<1.3	c0.44	<0.31	<0.36	NR	<0.37	<0.54	INEEUEXT-02-00557	
USGS-045	10/26/90	461-651	co.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	DOHID-22104	
	07/01/92		<0.2	<0.2	<0.2	<0.2	<0.2	co.2	<0.2	co.2	<0.2	<0.2	DOE/ID-22146	
USGS-046	08/18/80	461-650	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	IDO-22061	
	10/26/90		<0.2	<0.2	<0.2	c0.2	0 2	<0.2	<0.2	<0.2	<0.2	co.2	DOEAD-22104	
	07/01/92		c0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	DOWID-22146	
USGS-047	08/18/80	458-651	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	IDO-22061	
	10/26/87		<0.2	<0.2	<0.2	<0.2	<0.2	c0.2	<0.2	<0.2	<0.2	<0.2	DOE/ID-22074	
	09/30/88		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	DOHID-22089	
	04/25/01		<1	<1.4	<1.3	c1.5	<0.88	<1.3	<1.6	NR	4.1	<1.2	INEEUEXT-02-00557	MeCl=26J
	10/15/01		<0.24	<0.65	<0.38	4.3	<0.44	0.99J	<0.36	NU	<0.37	<0.54	INEEL/EXT-02-00557	
USGS-048	10/31/90	462-750	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	c0.2	<0.2	<0.2	<0.2	DOE/ID-22104	
USGS-051	10113/87	475-659	<0.2	<0.2	<0.2	<0.2	0.7	<0.2	<0.2	c0.2	<0.2	<0.2	DOE/ID-22074	
USGS-052	10/16/90	450-650	co.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	DOHID-22104	
USGS-059	10/06/87	464-657	c0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	DOE/ID-22074	
USGS-067	08/18/80	465-552	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	IDO-22061	
	10/06/87		<0.2	<0.2	<0.2	0.2	0.6	<0.2	<0.2	<0.2	<0.2	<0.2	DOEAD-22074	
ICPP-1782	10/04/02	475-515	<1	<1	<1	<1	<1	<1	<1	<2	<1	65	INEEUEXT-03-00251	
	11/01/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
	11/15/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
ICPP-1783	10/04/02	475-515	<1	<1	<1	<1	<1	<1	<1	<2	<1	53	INEEUEXT-03-00251	
	10/18/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	0.36 J	INEEUEXT-03-00251	
	11/01/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
	11/15/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
ICPP-1800	10/04/02	475-515	<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
	10/18/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEL/EXT-03-00251	
	11/01/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
	11/15/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEL/EXT-03-00251	
ICPP-1829	10/04/02	475-515	<1	<1	<1	<1	<1	<1	<1	<2	<1	13	INEEUEXT-03-00251	
	10/18/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
	11/01/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
	11/15/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1	INEEUEXT-03-00251	
ICPP-1831	10/04/02	475-515	<1	<1	<1	<1	<1	<1	<1	<2	<1	8.6	INEEUEXT-03-00251	
	10/18/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	19	INEEUEXT-03-00251	
	11/01/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	0.71 J	INEEUEXT-03-00251	
	11/15/02		<1	<1	<1	<1	<1	<1	<1	<2	<1	0.54 J	INEEUEXT-03-00251	
Perched Wells														
BLR-DP	06/26/01	375-385	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	DOHID-10967	CS2 = 2J
MW-1	07/23/01	359-369	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	DOHID-10967	
Mw-5	06/12/01	106-126	<5	<5	<5	<5	<5	<5	<5	<5	<5	2J	DOHID-10967	
Mw-20	06/23/01	133-148	45	<5	<5	<5	<5	<5	2J	<5	<5	<5	DOHID-10967	
PW-1	02/19/01	100-120	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	DOHID-10967	MeCl = 7J; CS2 = 2J
Pw-5	02/21/01	109-129	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	DOE/ID-10967	Acetonitrile = 66J
USGS-50	02/26/01	357-405	45	<5	<5	<5	<5	<5	<5	<5	<5	<5	DOHID-10967	

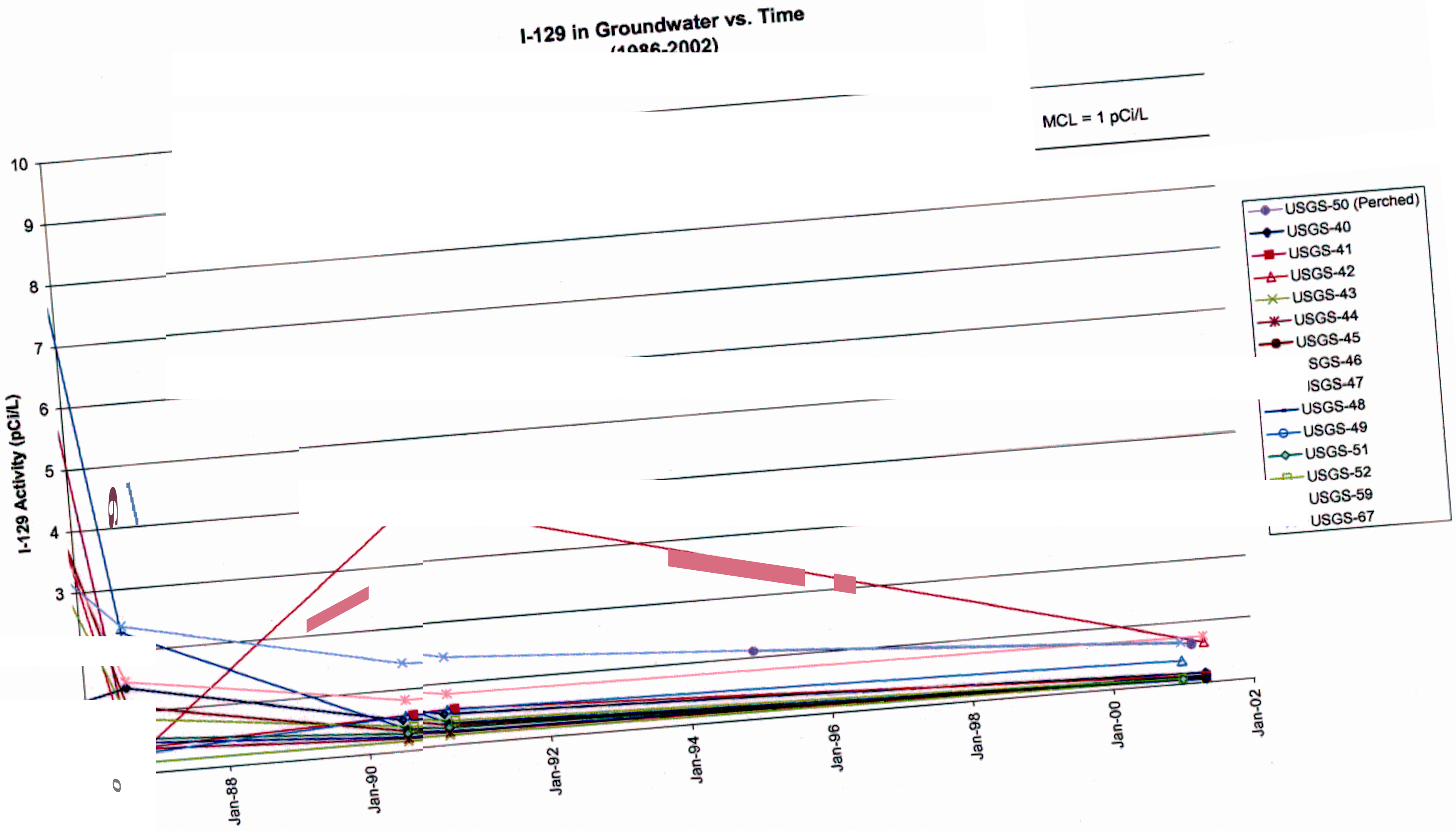
NR= not reported
NS = no standard established for drinking water
*** Total trlhalomethane (THM) MCL**

Tritium in Groundwater vs. Time
(1986-2002)

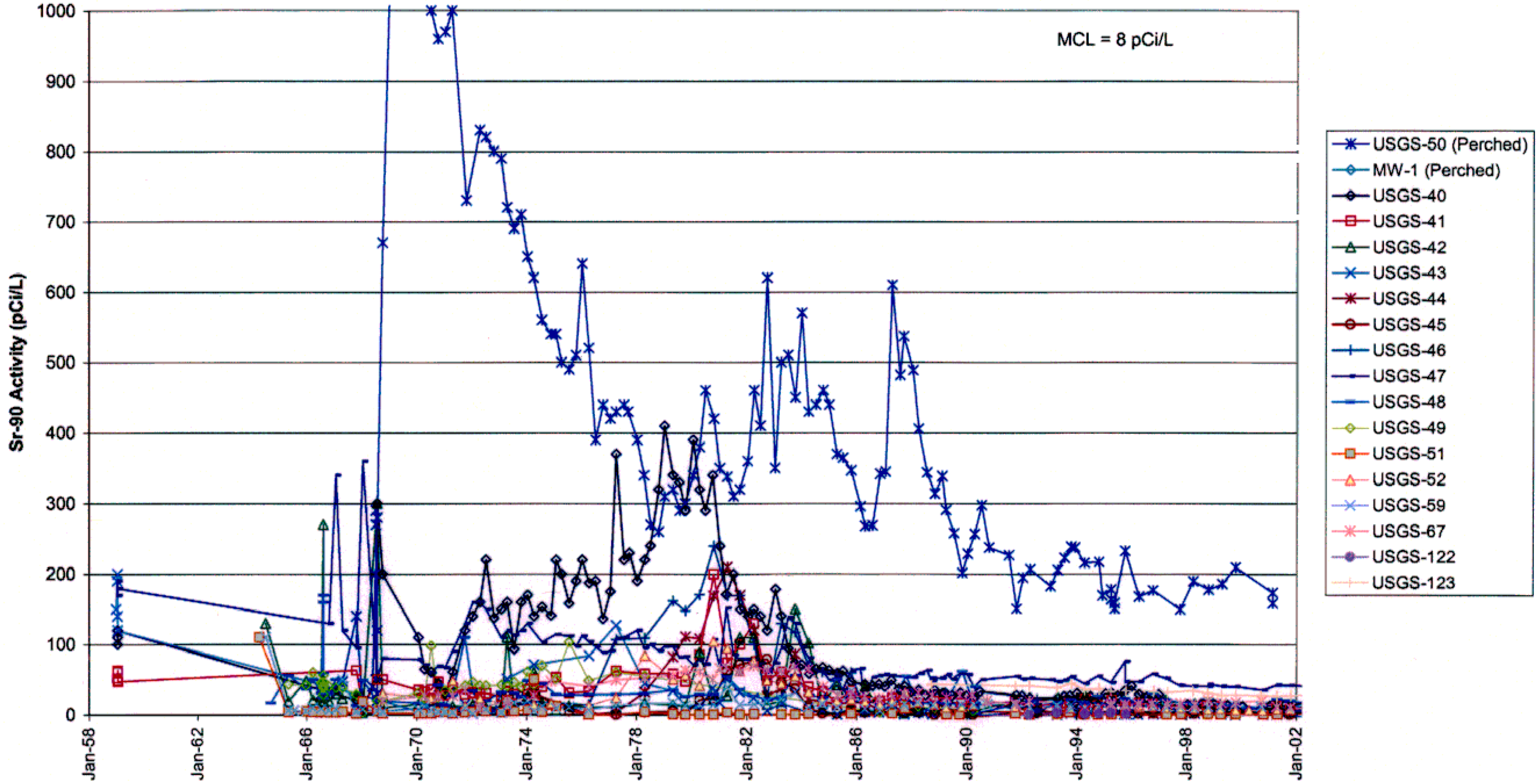


I-129 in Groundwater vs. Time

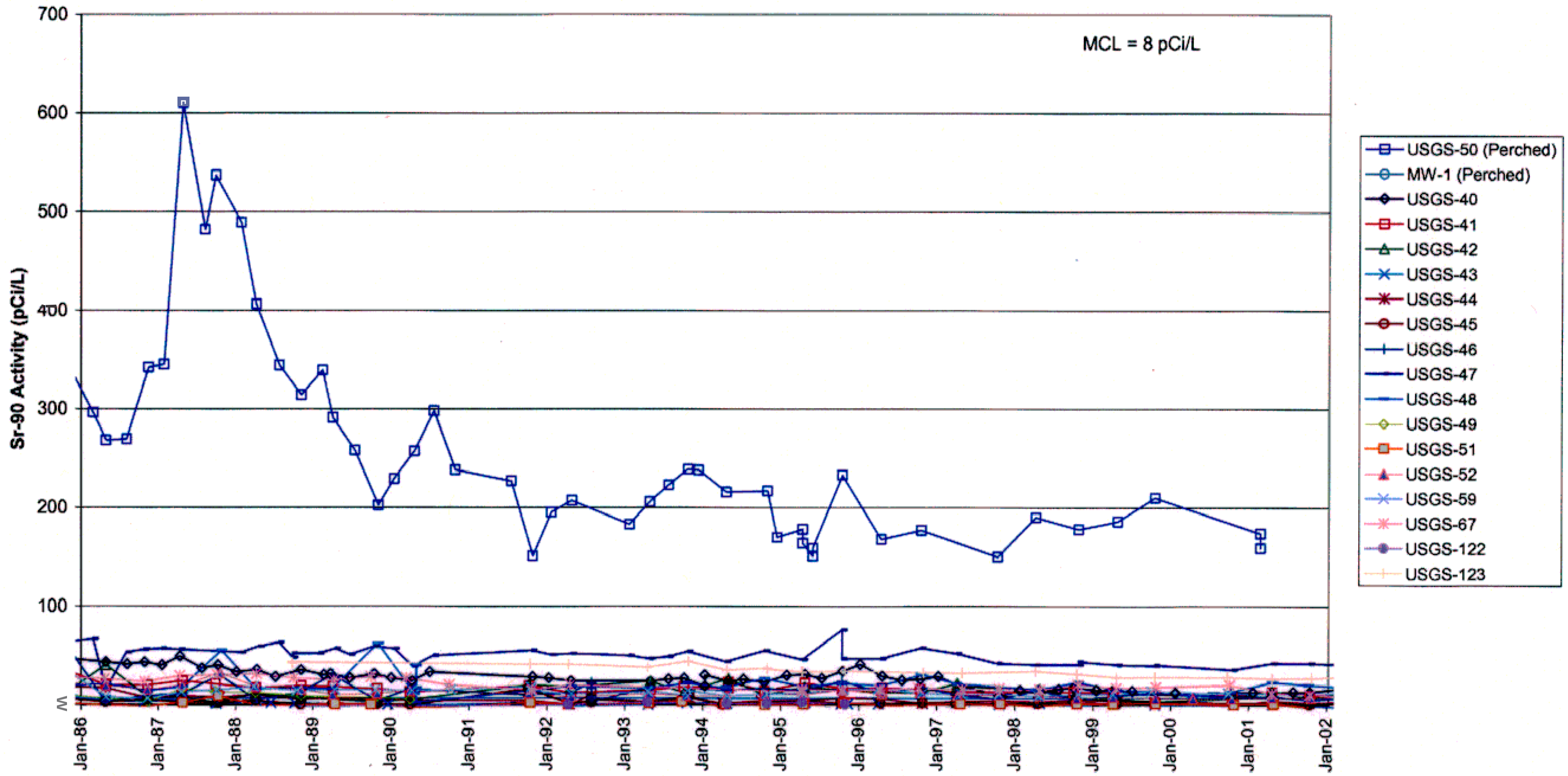


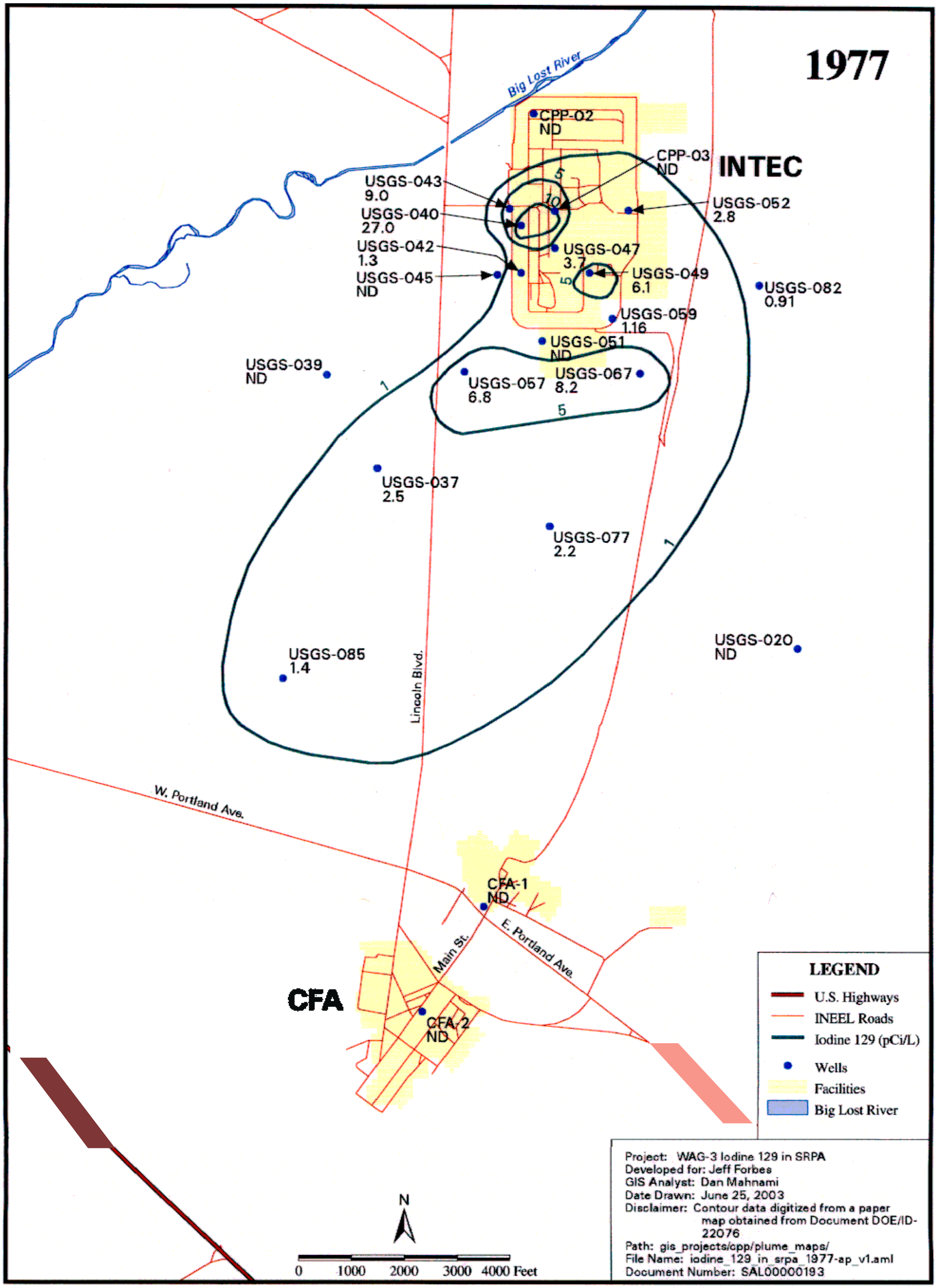

I-129 in Groundwater vs. Time
(1986-2002)
MCL = 1 pCi/L
I-129 Activity (pCi/L)
10
9
8
7
6
5
4
3
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
USGS-50 (Perched)
USGS-40
USGS-41
USGS-42
USGS-43
USGS-44
USGS-45
SGS-46
ISGS-47
USGS-48
USGS-49
USGS-51
USGS-52
USGS-59
USGS-67

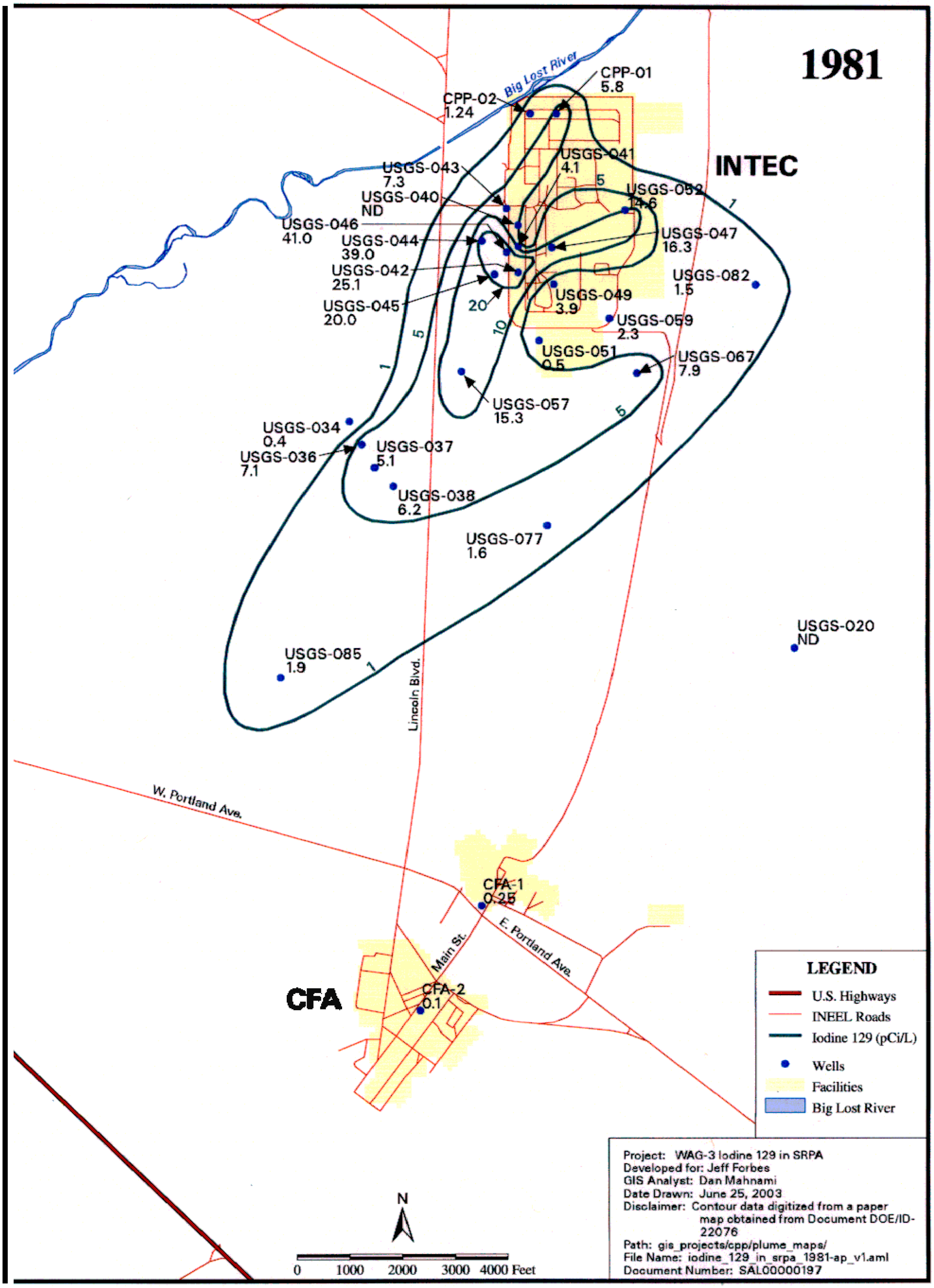
Sr-90 in Groundwater vs. Time

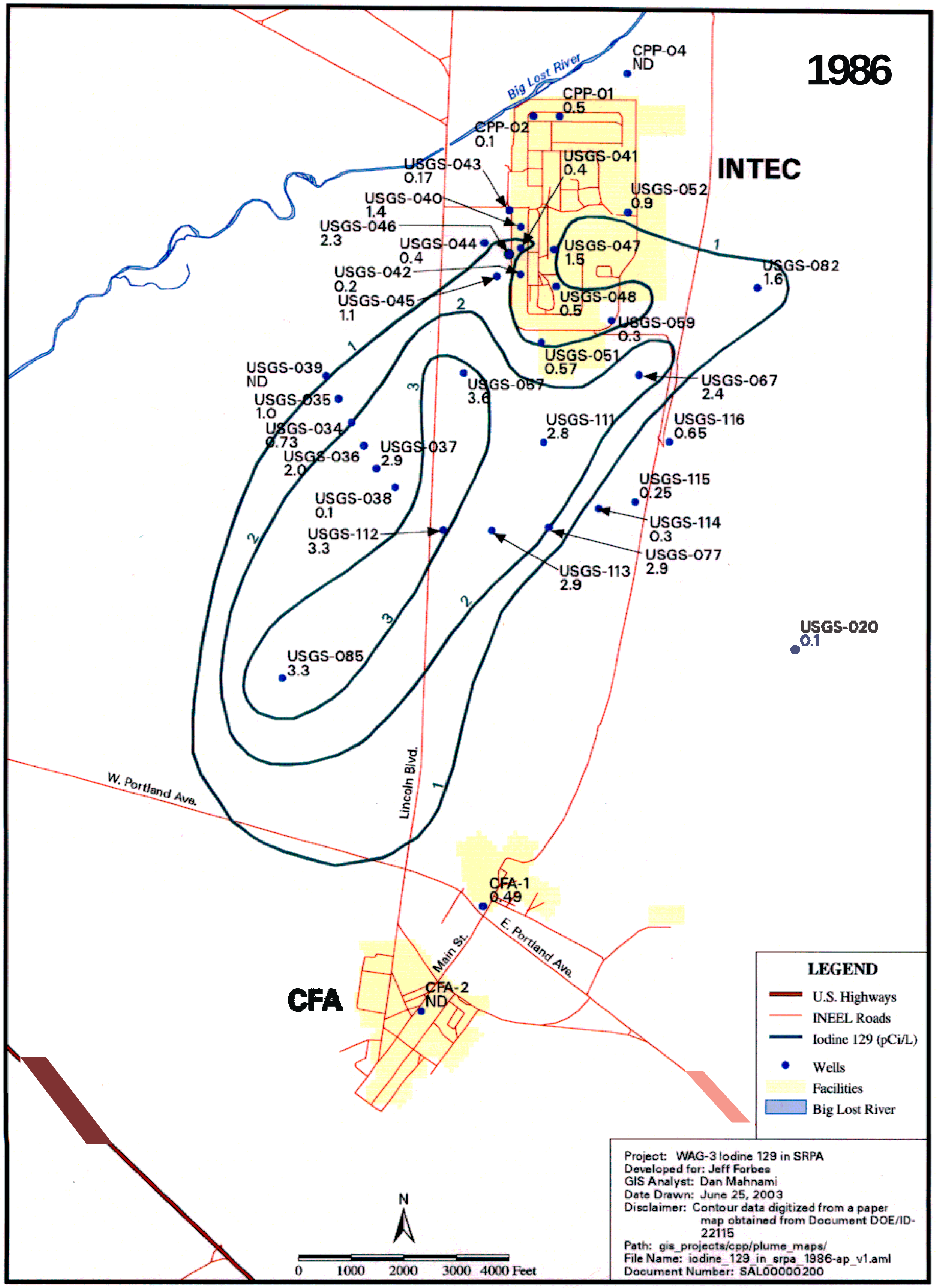


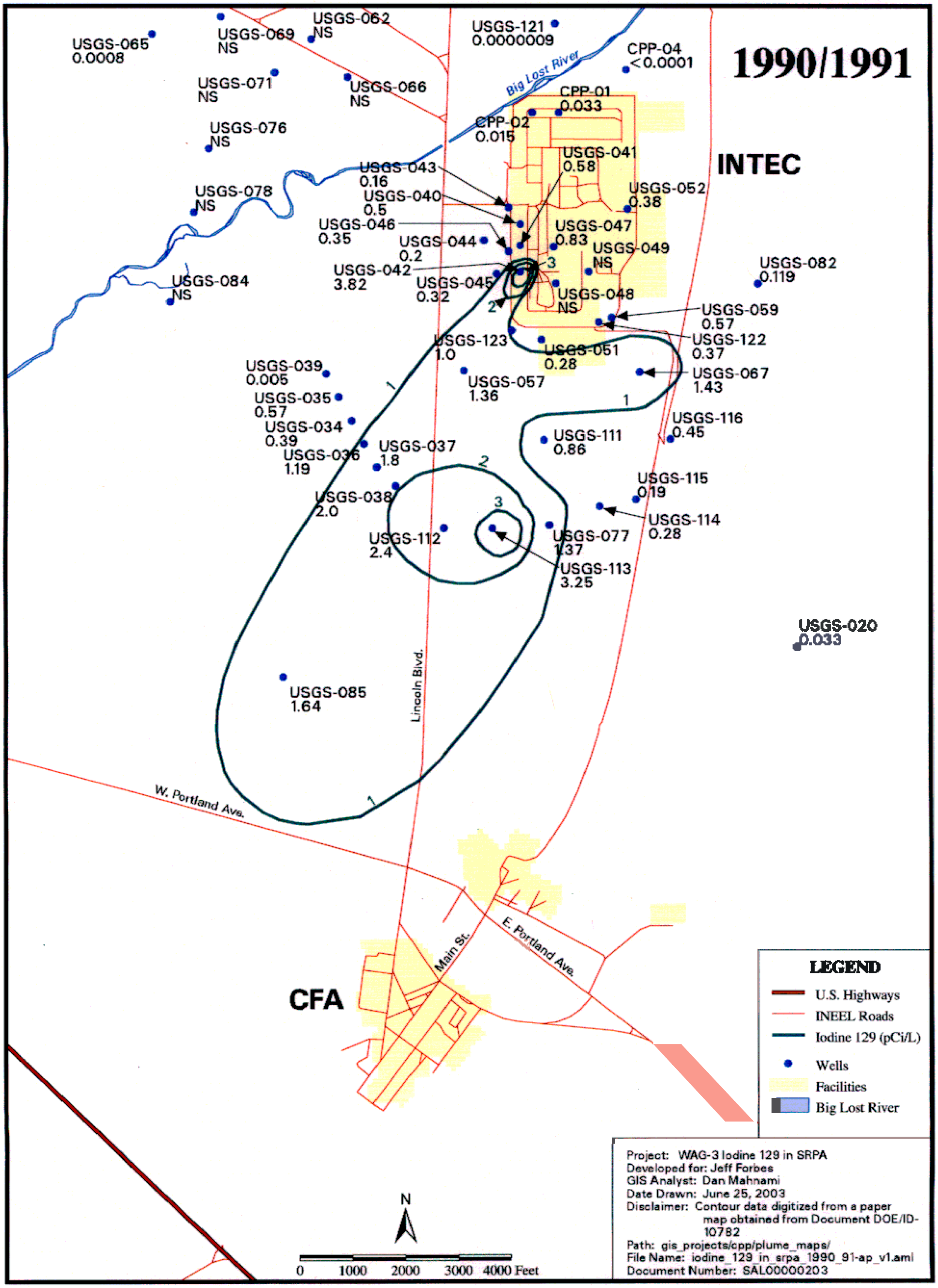
Sr-90 in Groundwater vs. Time
(1986-2002)

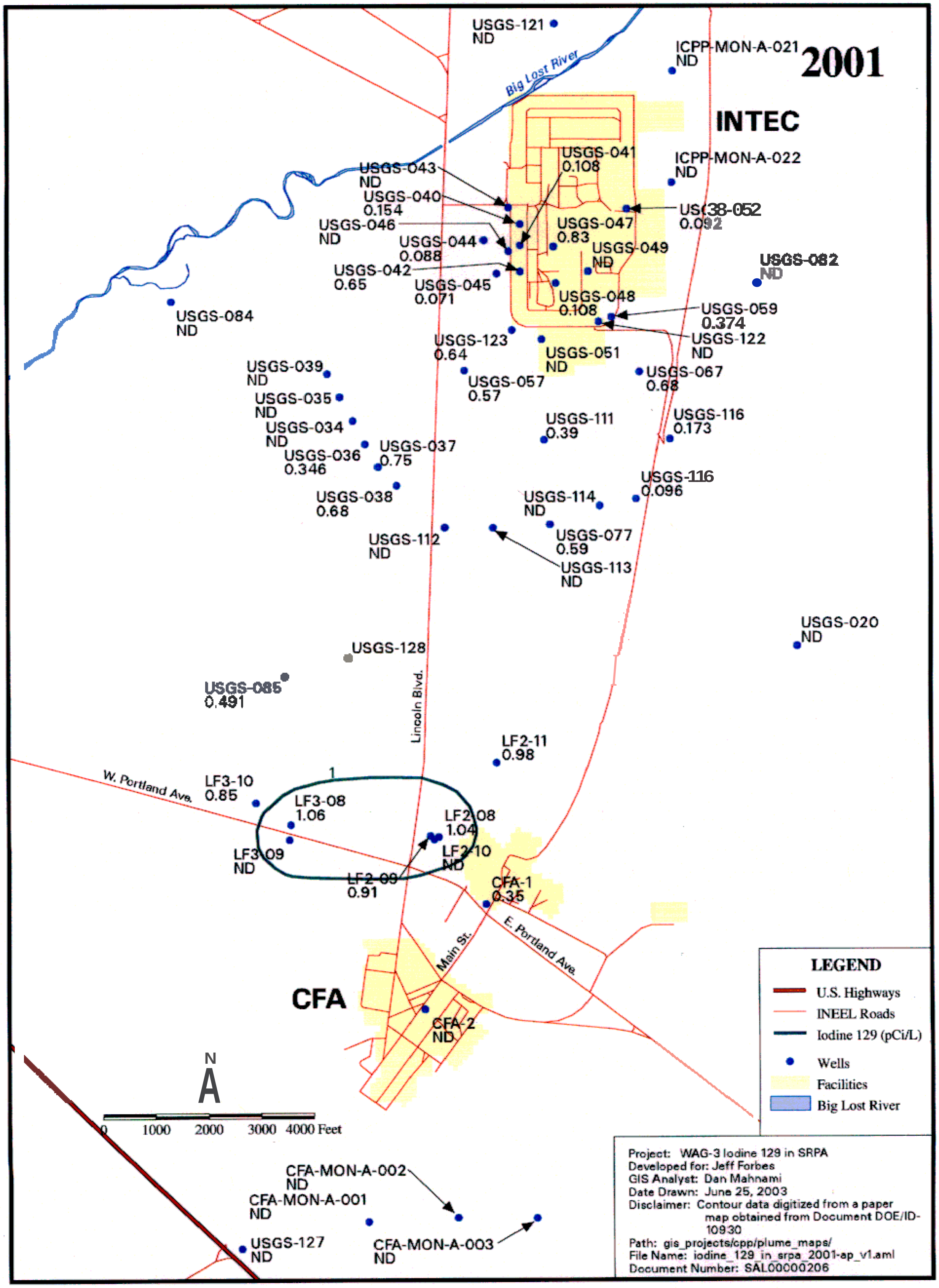



1977
INTEC
CFA
Big Lost River
CPP-02
ND
CPP-03
ND
USGS-043
9.0
USGS-040
27.0
USGS-042
1.3
USGS-045
ND
USGS-052
2.8
USGS-047
3.7
USGS-049
6.1
USGS-082
0.91
USGS-059
1.16
USGS-051
ND
USGS-039
ND
USGS-057
6.8
USGS-067
8.2
USGS-037
2.5
USGS-077
2.2
USGS-020
ND
USGS-085
1.4
Lincoln Blvd.
W. Portland Ave.
E. Portland Ave.
Main St.
CFA-1
ND
CFA-2
ND
LEGEND
U.S. Highways
INEEL Roads
Iodine 129 (pCi/L)
Wells
Facilities
Big Lost River
N
0 1000 2000 3000 4000 Feet
Project: WAG-3 Iodine 129 in SRPA
Developed for: Jeff Forbes
GIS Analyst: Dan Mahnami
Date Drawn: June 25, 2003
Disclaimer: Contour data digitized from a paper map obtained from Document DOE/ID-22076
Path: gis_projects/opp/plume_maps/
File Name: iodine_129_in_srpa_1977-ap_v1.aml
Document Number: SAL00000193


1981
INTEC
CFA
Big Lost River
CPP-01
5.8
CPP-02
1.24
USGS-041
4.1
USGS-043
7.3
USGS-040
ND
USGS-052
14.6
USGS-046
41.0
USGS-044
39.0
USGS-047
16.3
USGS-042
25.1
USGS-082
1.5
USGS-045
20.0
USGS-049
3.9
USGS-059
2.3
USGS-051
0.5
USGS-067
7.9
USGS-057
15.3
USGS-034
0.4
USGS-036
7.1
USGS-037
5.1
USGS-038
6.2
USGS-077
1.6
USGS-020
ND
USGS-085
1.9
Lincoln Blvd.
W. Portland Ave.
E. Portland Ave.
Main St.
CFA-1
0.25
CFA-2
0.1
LEGEND
U.S. Highways
INEEL Roads
Iodine 129 (pCi/L)
Wells
Facilities
Big Lost River
N
0 1000 2000 3000 4000 Feet
Project: WAG-3 Iodine 129 in SRPA
Developed for: Jeff Forbes
GIS Analyst: Dan Mahnami
Date Drawn: June 25, 2003
Disclaimer: Contour data digitized from a paper map obtained from Document DOE/ID-22076
Path: gis_projects/cpp/plume_maps/
File Name: iodine_129_in_srpa_1981-ap_v1.aml
Document Number: SAL00000197


1986
INTEC
CFA
Big Lost River
CPP-04
ND
CPP-01
0.5
CPP-02
0.1
USGS-043
0.17
USGS-041
0.4
USGS-052
0.9
USGS-040
1.4
USGS-046
2.3
USGS-044
0.4
USGS-047
1.5
USGS-082
1.6
USGS-042
0.2
USGS-045
1.1
USGS-048
0.5
USGS-059
0.3
USGS-051
0.57
USGS-039
ND
USGS-057
3.6
USGS-067
2.4
USGS-035
1.0
USGS-034
0.73
USGS-111
2.8
USGS-116
0.65
USGS-036
2.0
USGS-037
2.9
USGS-115
0.25
USGS-038
0.1
USGS-114
0.3
USGS-112
3.3
USGS-077
2.9
USGS-113
2.9
USGS-020
0.1
USGS-085
3.3
W. Portland Ave.
Lincoln Blvd.
CFA-1
0.49
E. Portland Ave.
Main St.
CFA-2
ND
LEGEND
U.S. Highways
INEEL Roads
Iodine 129 (pCi/L)
Wells
Facilities
Big Lost River
N
0 1000 2000 3000 4000 Feet
Project: WAG-3 Iodine 129 in SRPA
Developed for: Jeff Forbes
GIS Analyst: Dan Mahnami
Date Drawn: June 25, 2003
Disclaimer: Contour data digitized from a paper map obtained from Document DOE/ID-22115
Path: gis_projects/cpp/plume_maps/
File Name: iodine_129_in_srpa_1986-ap_v1.aml
Document Number: SAL00000200


1990/1991
INTEC
CFA
USGS-065 0.0008
USGS-069 NS
USGS-062 NS
USGS-121 0.0000009
CPP-04 <0.0001
USGS-071 NS
USGS-066 NS
Big Lost River
CPP-01 0.033
CPP-02 0.015
USGS-076 NS
USGS-041 0.58
USGS-043 0.16
USGS-040 0.5
USGS-052 0.38
USGS-078 NS
USGS-046 0.35
USGS-047 0.83
USGS-044 0.2
USGS-049 NS
USGS-082 0.119
USGS-042 3.82
USGS-045 0.32
USGS-084 NS
USGS-048 NS
USGS-059 0.57
USGS-122 0.37
USGS-123 1.0
USGS-051 0.28
USGS-039 0.005
USGS-057 1.36
USGS-067 1.43
USGS-035 0.57
USGS-034 0.39
USGS-116 0.45
USGS-111 0.86
USGS-037 1.8
USGS-036 1.19
USGS-115 0.19
USGS-038 2.0
USGS-114 0.28
USGS-112 2.4
USGS-077 1.37
USGS-113 3.25
USGS-020 0.033
USGS-085 1.64
Lincoln Blvd.
W. Portland Ave.
Main St.
E. Portland Ave.
LEGEND
U.S. Highways
INEEL Roads
Iodine 129 (pCi/L)
Wells
Facilities
Big Lost River
N
0 1000 2000 3000 4000 Feet
Project: WAG-3 Iodine 129 in SRPA
Developed for: Jeff Forbes
GIS Analyst: Dan Mahnami
Date Drawn: June 25, 2003
Disclaimer: Contour data digitized from a paper map obtained from Document DOE/ID-10782
Path: gis_projects/cpp/plume_maps/
File Name: iodine_129_in_srpa_1990_91-ap_v1.aml
Document Number: SAL00000203


2001
INTEC
CFA
Big Lost River
USGS-121 ND
ICPP-MON-A-021 ND
ICPP-MON-A-022 ND
USGS-041 0.108
USGS-043 ND
USGS-040 0.154
USGS-046 ND
USGS-044 0.088
USGS-042 0.65
USGS-045 0.071
USGS-047 0.83
USGS-049 ND
USGS-052 0.092
USGS-082 ND
USGS-048 0.108
USGS-059 0.374
USGS-122 ND
USGS-084 ND
USGS-123 0.64
USGS-051 ND
USGS-039 ND
USGS-057 0.57
USGS-067 0.68
USGS-035 ND
USGS-034 ND
USGS-111 0.39
USGS-116 0.173
USGS-036 0.346
USGS-037 0.75
USGS-116 0.096
USGS-038 0.68
USGS-114 ND
USGS-077 0.59
USGS-112 ND
USGS-113 ND
USGS-020 ND
USGS-128
USGS-085 0.491
Lincoln Blvd.
LF2-11 0.98
W. Portland Ave.
LF3-10 0.85
1
LF3-08 1.06
LF2-08 1.04
LF3-09 ND
LF2-10 ND
LF2-09 0.91
CFA-1 0.35
E. Portland Ave.
Main St.
CFA-2 ND
N
0 1000 2000 3000 4000 Feet
LEGEND
U.S. Highways
INEEL Roads
Iodine 129 (pCi/L)
Wells
Facilities
Big Lost River
CFA-MON-A-002 ND
CFA-MON-A-001 ND
USGS-127 ND
CFA-MON-A-003 ND
Project: WAG-3 Iodine 129 in SRPA
Developed for: Jeff Forbes
GIS Analyst: Dan Mahnami
Date Drawn: June 25, 2003
Disclaimer: Contour data digitized from a paper map obtained from Document DOE/ID-10930
Path: gis_projects/cpp/plume_maps/
File Name: iodine_129_in_srpa_2001-ap_v1.aml
Document Number: SAL00000206

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Appendix E

Letter from Allied Chemical

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011857

Allied Chemical

IDAHO CHEMICAL PROGRAMS - OPERATIONS OFFICE
550 Second Street
Idaho Falls, Idaho 83401

April 18, 1978

I-129 in Liquid
and Airborne Effluents
Cord-53-78

Jack T. Barraclough
U. S. Department of Interior
P. O. Box 2230
Idaho Falls, ID 83401

Dear Mr. Barraclough:

Reference: Letter, Mr. Jack T. Barraclough to F. H. Anderson, dated March 21, 1978

Because of the difficulty in removing and analyzing I-129 in airborne and liquid effluents, techniques have only recently been developed at the ICPP to accomplish these tasks. The measurement of I-129 in our service waste began in 1976, with those present in our airborne discharges beginning in January of 1978. The following table lists the measured I-129 releases at the ICPP.

Year	Liquid Releases	Airborne Releases
Feb 1978	3.22 mCi	24.99 mCi
Jan 1978	1.70 mCi	18.22 mCi
1977	19.82 mCi	---
1976	13.49 mCi	---

The major liquid effluents discharged from the ICPP which contain I-129 originate from the Process Equipment Waste (PEW) system. The PEW system processes all of the low to intermediate-level radioactive liquid waste solutions. These radioactive waste solutions are generated in large volumes, typically 50,000 to 100,000 gal/month and consist of solutions collected from decontamination of process equipment, process cells, and from floor drains. The I-129 present in the liquid effluents is essentially the total amount released from ICPP during normal plant activities in the absence of the Waste Calcining Facility (WCF) operation. When the WCF is operating, it is the primary contributor of airborne I-129 releases at the ICPP.

0118577

Jack T. Barraclough
Cord-53-78
April 18, 1978
Page 2

As seen in the above table, measurements of I-129 in our discharges only date back to 1976 for liquid effluents and January 1978 for the airborne releases. Our data base is not sufficiently large to quantitatively determine the yearly liquid and airborne releases of I-129 since 1953. However, it appears from the monthly liquid discharge levels that during fuel processing operations and decontamination activities approximately 0.5 to 2.5 mCi of I-129 is discharged monthly via the aqueous waste discharge system.

The I-129 levels present in our liquid effluents are primarily dependent upon the PEW evaporator. If the discharge rate of I-129 in the service waste is assumed to be roughly continuous, then the ICPP could have discharged as much as 750 mCi of I-129 to the aquifer since 1953.

It is possible to calculate the approximate total I-129 inventory at the ICPP by two different methods. The first method is based on the quantity of fuel processed at the ICPP since 1953 while the second considers the quantity of high-level liquid waste calcined. The calculations and assumptions needed for determining this I-129 inventory based on the first method have been made on Attachment 1. These calculations indicate that approximately 5 Ci of I-129 have been present in processed fuel at the ICPP from 1953 to 1977. These calculations are fairly rough and should be considered as approximations.

The second method is shown in attachment 2 which indicates that the total I-129 inventory is approximately 6.2 Ci based on a recent analysis of calcine feed from WM-185. Since the WCF operation is the principle source of airborne I-129 releases, significant discharges to the atmosphere only began in 1963. The coefficient of variations stated for these analytical results only consider the uncertainty incurred in analysis and not the obvious uncertainty present for I-129 in the different calcine feeds.

The errors expressed in these two methods represent the standard deviation of the mean except for the total fuel burnup in attachment 1 and the analytical measurements in attachment 2. These latter errors are assigned based on the uncertainty in the analytical method and the quantity of fuel burned up. These errors are approximately one standard deviation.

011857

Jack T. Barraclough
Cord-53-78
April 18, 1978
Page 3

The chemical form of I-129 in the atmospheric discharges has not been determined; however, it has been postulated that mercuric iodide or methyl iodide are the predominant species, but this has not been confirmed.

If you have any questions concerning this matter, please contact R. S. Roberts at ext. 3560.

Very truly yours,

Ormand L. Cordes, Manager
Operational & Environmental
Safety Office

zs

cc: F. H. Anderson
H. Lawroski
F. L. McMillan
B. C. Musgrave
B. L. Rich
R. S. Roberts
B. R. Wheeler
O. L. Cordes - 2

011857

Method 1 Total I-129 that has been at the ICPP based on fuel processing operations.

Jack T. Barraclough
O. L. Cordes
April 5, 1978
Page 3
Attachment 1

ICPP I-129 Inventory from Approximately 1953 to 1977

Fuel Type		U-235 Product (kg)	Burnup Percent	Burnup U-235 (kg)
SRP, Hanford, TRA, MTR	Aluminum	9.85×10^3	32	4.64×10^3
	Zirconium	*	*	1.51×10^3
EBR-II, SIR	Stainless Steel	1.45×10^3	7	1.09×10^2
		*		6.26×10^3 kg ± 10%

* Classified Information

$$\frac{6.26 \times 10^6 \text{ g destroyed} \pm 10\%}{1.19 \text{ g U-235 destroyed/MWd}} = 5.26 \times 10^6 \text{ MWd} \pm 10\%$$

$$(5.26 \times 10^6 \text{ MWd} \pm 10\%)(8.64 \times 10^4 \tfrac{\text{sec}}{\text{day}})(10^6 \tfrac{\text{W}}{\text{MW}}) = 4.54 \times 10^{17} \text{ W-sec} \pm 10\%$$

$(4.54 \times 10^{17}$ W-sec $\pm 10\%)(3.12 \times 10^{10}$ fissions/W-sec$) =$
1.42×10^{28} fissions $\pm 10\%$

I-129 fission yield $= 9.92 \times 10^{-3} \pm 3\%$

$(1.42 \times 10^{28}$ fissions $\pm 10\%)(9.92 \times 10^{-3} \pm 3\%) = 1.41 \times 10^{26}$ atoms of I-129 $\pm 10.5\%$

$T_{1/2}$ of I-129 $= 1.64 \times 10^7$ years $\pm 4\%$. $\lambda = 1.34 \times 10^{-15}$ sec$^{-1} \pm 4\%$

$n\lambda = (1.41 \times 10^{26}$ atoms of I-129 $\pm 10.5\%)(1.34 \times 10^{-15}$ sec$^{-1} \pm 4\%) =$
1.89×10^{11} d/s $\pm 11.2\%$

$$\frac{1.89 \times 10^{11} \text{ d/s} \pm 11.2\%}{3.7 \times 10^{10} \text{ d/s/Ci}} = 5.11 \text{ Ci of I-129} \pm 11.2\%$$

0118857

Method 2 Calculational airborne I-129 releases since 1963 based on WCF operations.

Jack T. Barraclough
Cord-53-78
April 5, 1978
Page 4
Attachment 2

WCF Operation

Run #	Date of Run	Hot Feed (gal)	Solids (ft^3)
1	12/8/63 → 10/15/64	511,000	7,600
2	4/1/66 → 3/4/68	989,000	14,590
3	8/14/68 → 6/4/69	329,000	5,595
4	8/3/70 → 1/3/71	224,000	4,555
5	9/23/71 → 5/11/72	300,000	5,230
6	5/26/73 → 5/9/74	386,000	6,520
7	5/30/75 → 1/24/77	375,900	7,227
8	9/1/77 → 2/28/78	240,000	4,400
		3,354,900	55.717

Recent measurements of calciner feed indicated an I-129 level of 1.36 μCi/gal ± 15%†. Approximately 68% ± 15%† of the iodine present in the feed is released to the atmosphere via the stack. Therefore, the total estimated I-129 released from the ICPP stack is:

$(1.36 \times 10^{-6}$ Ci/gal ± 15%)(.68 ± 15%)(3,354,900 gal ± 1%) = 3.1 Ci ± 21%
****

The I-129 present in the high-level waste already calcined is:

$(1.36 \times 10^{-6}$ Ci/gal ± 15%)(3,354,900 gal ± 1%) = 4.56 Ci of I-129 ± 15%

Approximately 1.2×10^{6} gal of high-level waste remains to be calcined. Assuming that 1.36 μCi/gal of I-129 is representative of the high-level waste yet to be calcined, the total I-129 in this waste is:

$(1.2 \times 10^{6}$ gal ± 1%)$(1.36 \times 10^{-6}$ Ci/gal ± 15%) = 1.63 Ci of I-129 ± 15%

In order to determine the total I-129 since 1953 as was done in method 1, it is necessary to compute the I-129 in the high-level liquid waste.

Thus, the total estimated I-129 inventory is:

(1.63 Ci ± 15%) + (4.56 Ci ± 15%) = 6.19 Ci ± 12%

† Personal communication with S. J. Fernandez